International Marine Engineering

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CONTRACT TRIAL PERFORMANCE OF THE UNITED STATES BATTLESHIP LOUISIANA.

BY A. F. BOWEN AND H. B. GREGORY.

GENERAL DESCRIPTION.

The armored battleship *Louisiana* is of the *Connecticut* class. The bill for this class as passed by congress stated that one ship should be built in a private yard and one in a government yard. The contract for building the *Louisiana* was awarded to the Newport News Shipbuilding and Dry Dock Company, they being the lowest bidders, while the New York navy yard was designated by the government as builders of the *Connecticut*. The successful bidders signed the contract October 15, 1902, laid the keel February 7, 1903, and launched the ship August 27, 1904.

HULL DIMENSIONS.

Length between perpendiculars (also L. W. L.)	450 ft.	0	in.
Length over all	456 ft.	4	in.
Projection of ram forward of F.P.	6 ft.	4	in.
Breadth molded	76 ft.	5½	in.
" extreme	76 ft.	10	in.
Ratio length to beam		5.856	
Depth molded to main deck side at midship section	43 ft.	1⅜	in.
Draft	24 ft.	6	in.

THE BATTLESHIP LOUISIANA ON TRIAL TRIP.
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The contract price of the *Louisiana* was $3,990,000. There was apportioned to hull (not including armor, ordnance, anchors, etc.) the sum of $2,990,000, and to machinery $1,000,000. The contract time for completion was 41 months, thus making the date March 15, 1906. The speed to be developed was 18 knots for four consecutive hours on a mean draft of 24 feet 6 inches, the maximum air pressure finally allowed being 2¼ inches and the average air pressure not to exceed 2 inches.

The complement is as follows:

Admiral	1	Seamen branch	401
Chief of staff	1	Artificer "	45
Commanding officer	1	Engine room branch	226
Wardroom officers	19	Special "	33
Junior "	20	Messmen "	27
Warrant "	9	Commissary "	17
Officers	51	Marines	72
		Additional for Flag	19
Men	840		840
Total	891		

Displacement, normal—24-foot 6-inch draft	15,970	tons	
" per inch—" " " " "	63.2	tons	
Area of immersed midship section	1,808	sq. ft.	
Area of load water plane	26,560	sq. ft.	
Area wetted surface at normal draft	44,500	sq. ft.	
Center of gravity of L. W. L. plane aft of M. S.	4.4	ft.	
Center of buoyancy above bottom of keel	13 ft.	4	in.
" " " aft of M. S.	0.765	ft.	
Transverse metacenter above center of buoyancy	18 ft.	9½	in.
Longitudinal " " " " "	538 ft.	6	in.
Coefficient of fineness—block	0.6592		
" " " —midship section	0.9604		
" " " —L. W. L. plane	0.7683		
" " " —cylindrical	0.6963		
Number of frames (spaced 4 feet throughout)	112		
" " " watertight compartments	314		

THE UPPER DECK.

The upper deck extends between the two 12-inch turrets, and forms the upper part of the superstructure. Over the forward

end is built the bridge deck, having thereon the chart room and the captain's emergency cabin, and above this is the flying bridge. Over the after end is the signal bridge, at the level of the top of the signal tower.

The following boats are carried on the upper deck: one 50-foot steam cutter (a 40-foot steam cutter is temporarily fitted); two 36-foot steam cutters; one 36-foot launch; three 33-foot launches; five 30-foot cutters; one 30-foot barge; two 30-foot whaleboats; one 30-foot whaleboat gig; two 20-foot dinghies; one 16-foot dinghy; one 14-foot dinghy.

THE MAIN DECK.

This deck extends from the stem to the stern, and is covered in part by the upper deck extending between the two turrets. The two 12-inch turrets with four 12-inch guns, and the four 8-inch turrets with eight 8-inch guns are mounted on this deck. The six 3-inch guns are covered by the upper deck.

In the forward part of the superstructure is located the crew's galley, and about amidships the officers' galley; while just forward of the machinery hatch are the executive and paymaster's offices.

THE GUN DECK.

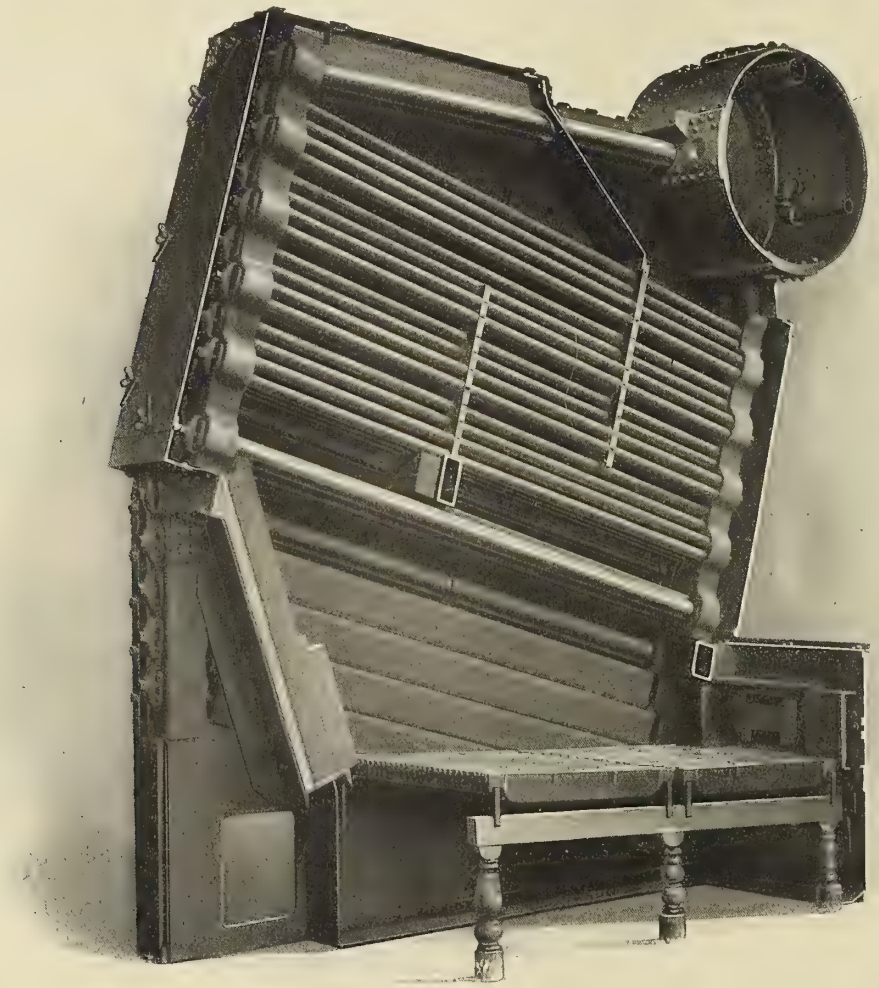
Forward on this deck are the crew's showers, lavatories and the windlass engine. Then comes the casemate containing the twelve 7-inch guns in separate armored compartments. Abaft the casemate are located the quarters for the admiral, captain, chief of staff, and wardroom officers.

THE BERTH DECK.

The forward part of the berth deck contains the paints and oils, bandroom, isolation ward, sick bay and lavatory, operating room, dispensary, refrigerating plant, laundry, machinists' and petty officers' quarters; while the after part contains the wardroom, junior and warrant officers' staterooms, and dining rooms.

ARMOR.

There is fitted a complete water-line belt 9 feet 3 inches wide amidships, stepped down at the ends. In wake of the machinery spaces the armor will be 11 inches at the top, tapering to 9 inches at the bottom. Forward and aft the armor will step down to 9 inches at the top and 7 inches at the bottom, then to 7 inches at top and 5 inches at bottom, then to 5 inches constant thickness, and then to 4 inches constant thickness.



SECTION THROUGH ONE OF THE BOILERS, SHOWING HEADERS AND BAFFLES

Above the belt armor are the lower casemate of 6 inches and the upper casemate 7 inches thick, respectively. There are two 12-inch elliptical balanced turrets, forward and aft, respectively, revolving over circular barbettes. The turret armor is 12 inches thick on the port plates, and 8 inches thick on the sides and back. There are also four 8-inch elliptical broadside turrets, the port plates of which are 6½ inches thick, while the back and sides are 6 inches.

ORDNANCE.

Main battery: four 12-inch breech-loading rifles; eight 8-inch breech-loading rifles; twelve 7-inch rapid-fire rifles.

Secondary battery: twenty 3-inch 50-caliber rapid-fire rifles; ten 3-pounder semi-automatic Hotchkiss rapid-fire rifles; two 1-pounder automatic guns; two .30-calibre machine guns.

The ship has also four 21-inch submerged torpedo tubes, two forward and two aft, with the necessary compressors, accumulators, separators, etc.

EQUIPMENT.

Electric Plant.—There are eight 100-kilowatt generating sets furnished by the General Electric Company, four of which are located in the forward dynamo room, and four in the after dynamo room. The lighting installation consists in general of about 1,100 incandescent 16-candlepower lamps; 1,758 incandescent 5-candlepower lamps for use in the battery control instruments; one arc lamp in each of the fire rooms, and two in each of the engine rooms, making a total of ten arc lamps. The eight vertical cross compound, 100-kilowatt dynamo engines have cylinders 10 and 18 inches in diameter with the common stroke of 10 inches.

The same company also furnished the searchlights, of which there are four 30-inch and two 60-inch, controlled by hand, and two sets of night signalling apparatus; besides various other electrical machinery.

Anchor Windlass.—The steam windlass is of the vertical Hyde type, located on the main deck forward, while the engine is outside of the windlass house, and placed on the gun deck.

Winches.—All told there are six electrically driven deck winches, four of which are on the main deck forward and aft, the other two being situated on the upper deck.

Steering Engine.—In the steering room there is a combined hand and steam steering engine of the Williamson Brothers type, double cylinders, 15 inches diameter by 12 inches stroke. The engine is controlled from the flying bridge, conning tower, and communicating room, by wire rope actuating the engine valve.

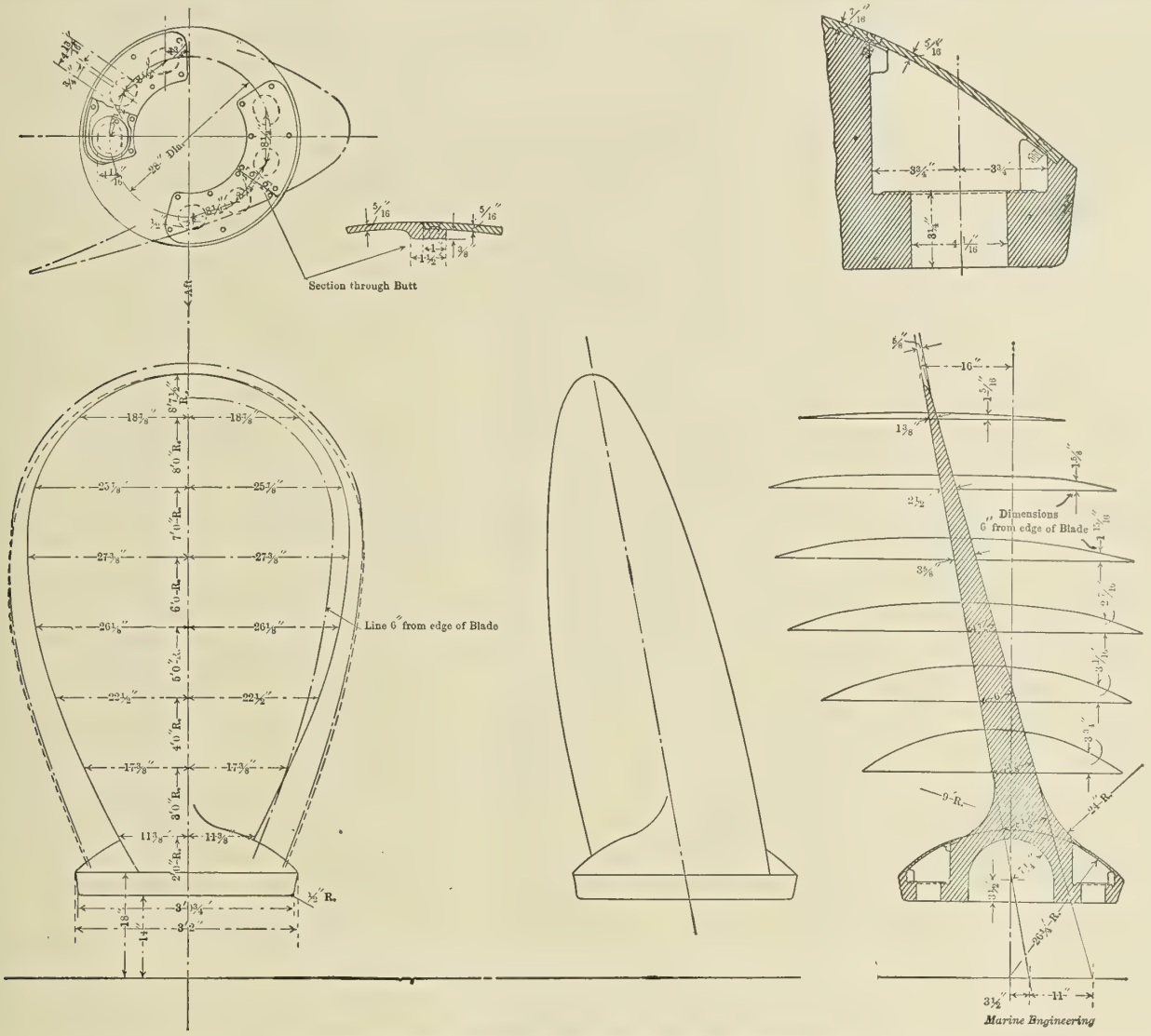
Ventilation System.—The ventilation is accomplished by means of sixteen sets, the greater number being on the plenum system, and supplying air to the several compartments. About 90,600 cubic feet of air is supplied per minute, and 13,846 cubic feet exhausted.

PROPELLING MACHINERY.

The main engines, two in number, are of the four-cylinder, vertical, inverted, direct-acting, triple expansion type, placed abreast in two separate watertight compartments with communicating watertight door at the working platform. The order of the cylinders, beginning forward, is: forward L. P., H. P., I. P., and after L. P. The crank sequence is: H. P., I. P., F. L. P., and A. L. P., all crank angles being ninety degrees. The engines are right and left, and turn the propellers inboard when going ahead. The designed indicated horsepower of the main engines was 16,500 at about 120 revolutions per minute, with a steam pressure of 250 pounds at the high-pressure steam chest.

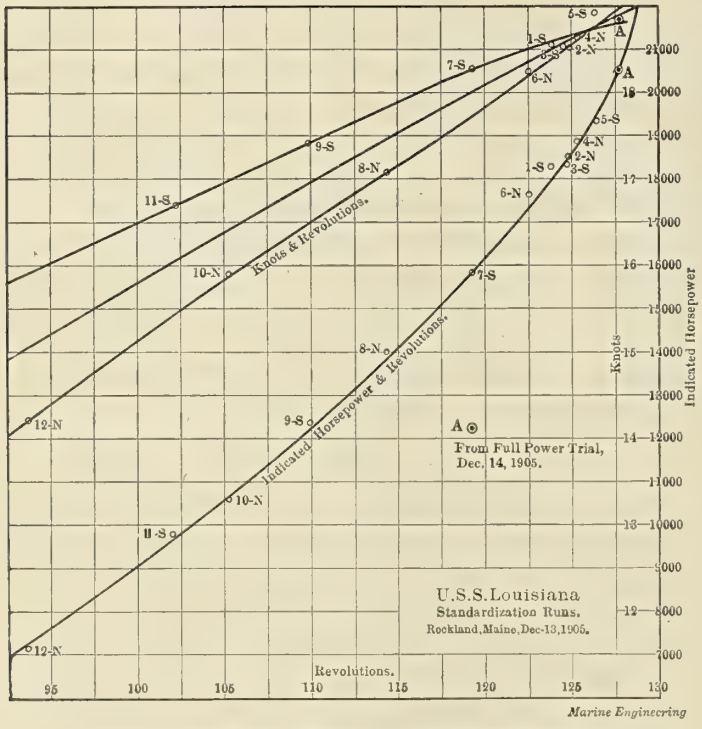
The main engine cylinder casings are of cast iron, and are fitted with cast iron liners in the barrels and valve chests. The cylinder liners make steam tight joints with the casings both at the top and the bottom, and the space between the liner and the casing forms the steam jacket for the cylinder barrel. All cylinder covers, except the H. P., are also jacketed.

The framing of the main engines is in accordance with general naval practice, consisting of forged steel cylindrical columns,



LAYOUT OF ONE PROPELLER BLADE FOR BATTLESHIP LOUISIANA.

twelve in number, supporting the cylinder, crosshead guides, etc. They are flanged top and bottom for securing to the cylinders and the bedplates, and have enlarged facings for the athwartship and longitudinal tie rods, braces, and reversing shaft bearings. The columns are tied fore and aft by heavy cast steel horizontal I braces and forged steel horizontal and diagonal rods, and strengthened athwartship by forged steel X frames, extending from top to bottom of columns, and horizontal tie rods at the center of the columns and X frames. Additional stiffness is afforded the engines by fore-and-aft and athwartship tie rods, between the cylinders of opposite engines, and between the forward and after engine room bulkheads and the engine cylinders.



CURVES REPRESENTING RESULTS OF STANDARDIZATION RUNS.

Heavy cast steel bed plates, consisting of longitudinal and cross I girders, secured to strong foundations built in the hull structure, provide a solid base for the engines. Each bed plate is in three sections securely bolted together. Two main bearings, consisting of bottom brass and cast steel cap, both lined with white metal, are carried in each section.

The main valves are of single ported piston type. They are built up with top and bottom cast steel heads, and a steel tube distance piece between the heads. Each head is fitted with a single cast iron packing ring and cast steel follower. The H. P. cylinders have one valve, and the I. P. and L. P. cylinders two valves each. A balance piston, fitted at the top of each valve stem and working in a small cylinder in the top valve chest cover, is provided to relieve a part of the weight of the valve gear.

The latter is of the double bar Stephenson link and sliding block type. The H. P. valve stem connects direct to its link block, while the two valve stems of each I. P. and L. P. cylinder are secured to a crosshead, which in turn is connected to the link block.

Each main engine is handled by a vertical steam reversing engine with oil controlling cylinder, secured to the H. P. cylinder casing. A reversing shaft is carried in bearing brackets secured to the front of the engine columns and provided with an arm, for each link, fitted with adjustable cut-off block, and two arms for the reversing engine connecting rods. The reversing engine is controlled by a lever at the working platform.

An 11-inch balance throttle valve is provided for each engine. The valve is operated by a large handwheel at the working platform.

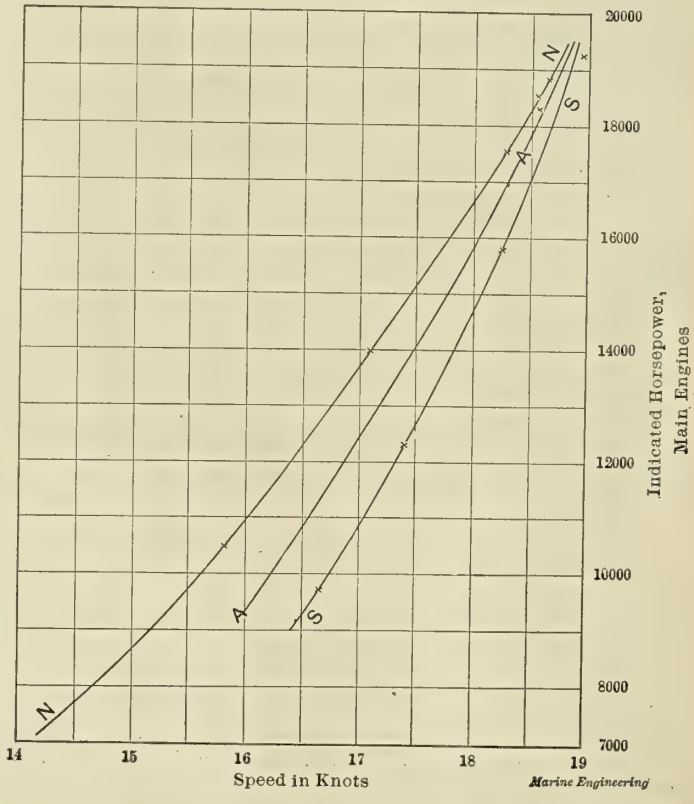
The pistons are of the ordinary cone shape, the H. P. being of cast iron and the I. P. and L. P. of cast steel. All pistons are fitted with forged steel followers secured to the piston bodies by studs having square shoulders, to prevent turning, where they pass through the followers. The H. P. and I. P. pistons are each fitted with one solid packing ring, set out by 18 and 27 steel springs respectively. The L. P. piston packing rings are in two rings of six sections each, set out by 32 steel springs.

The piston rods are of nickel-steel, oil tempered and annealed, and bored axially. They are ground cylindrically true, and polished. Each end is tapered, the upper for the reception of the piston and the lower for the crosshead. The crossheads are also of nickel-steel, and carry a cast steel slipper, which is lined with white metal on the sliding faces.

The go-ahead crosshead guides are of cast iron, hollow for water circulation, and are bolted to the top and bottom horizontal fore-and-aft I braces of the engine framing, and also hung from the cylinder bottoms by small column hangers. The backing guides are of cast steel, and are bolted to facings on the go-ahead guides.

The connecting rods are of the same material as the piston rods, and have axial holes. They are forked at the upper end to carry the crosshead brasses, and the lower end is faced to receive the crank pin brasses. All the brasses are secured by a forged steel cap and bolts.

All the eccentrics are in two parts, which are bolted together and keyed to raised seatings on the crank shafts. The go-ahead eccentrics are arranged for slight adjustment, by means of a slot



SPEED-POWER CURVES FROM STANDARDIZATION RUNS.

of greater width than the key, which permits their being shifted radially. The space between the sides of the key and slot is fitted with filling pieces, to prevent the eccentrics from slipping.

The eccentric straps are of composition, lined with white metal. They are in halves, fitted with distance pieces and bolted together. To the upper part of the straps are secured the eccentric rods, which are of nickel-steel. The upper ends of the rods are forked to span the main links at the link pins, adjustable brasses being fitted for these pins.

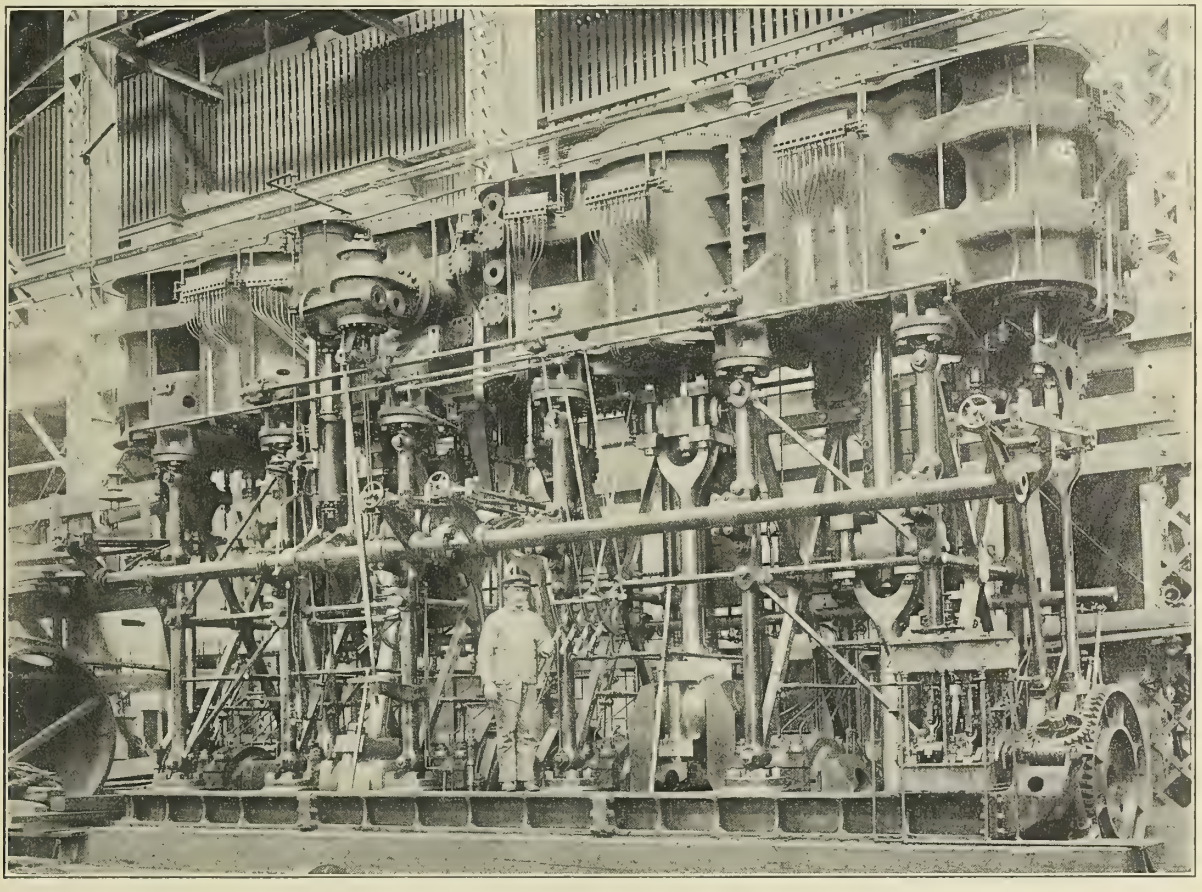
Each main engine has six sections of shafting, as follows:—two sections of crank shaft, and one each of thrust, line, stern tube, and propeller shafts. All shafting is hollow forged nickel-steel. The stern tube shafts, which cannot be readily examined, are protected against the corrosive action of the sea water by a brass casing, shrunk on. Paint alone protects the propeller shafts against this corrosion, as they are easily accessible for examination, cleaning, and repainting, whenever the vessel is docked. Both the stern tube and propeller shafts are fitted with heavy brass journals at the stern tube and strut bearings.

All shaft couplings are of the standard flange type, forged to the shafts, except the forward coupling of the stern tube shaft, and the outboard coupling connecting the stern tube and propeller shafts. The former consists of a forged steel collar secured to a raised seating on the shaft by four keys. Behind this collar is a ring in halves, which fits around the shaft and against the shoulder of the collar seating, both collar and ring being through bolted to the after coupling of the line shaft. The outboard coupling consists of a forged steel sleeve, taper bored from each end to center, for receiving the tapered shaft end. The sleeve is secured to the shaft ends by four keys and two cotters. The sleeve couplings are covered by a watertight cast composition casing, the space between the casing and coupling being filled with tallow and rosin melted together.

There are six main bearings for each complete crank shaft, consisting of hollow cap and brass for water circulation, and lined with white metal. Two steady bearings are provided for each thrust shaft, and two spring bearings for each line shaft. Each end of the stern tubes is fitted with a lignum vitae lined bearing for the stern tube shafts, and both struts are provided with a similar bearing for the propeller shaft. A stuffing box and gland, for preserving watertightness, are fitted at the forward end of each stern tube, in the shaft alley. Wherever the shafting pierces a watertight bulkhead a shallow stuffing box is fitted around it.

There is one thrust bearing for each main engine, of the ordinary horse shoe type. It consists of a cast iron pedestal bolted to a cast iron sole plate, which is securely riveted to the foundation built in the hull structure. The lower part of the pedestal forms an oil trough in which the lower part of the thrust collars turn, the trough being fitted with a water circulating coil for cooling the oil. A steady bearing is at either end of the pedestal. There are thirteen horse shoes of cast steel, made hollow for the circulation of cooling water, and lined with white metal on the bearing surfaces. Each horse shoe is independently adjusted fore-and-aft by screwed steel side rods and clamp nuts.

The turning gear, for each engine, consists of a double engine, which drives by worm gearing a large worm wheel keyed to the after crank shaft coupling. There is also a ratchet attachment for turning by hand.



STARBOARD ENGINE OF BATTLESHIP LOUISIANA, ERECTED IN SHOP.

An efficient water service fitted to the engines, and supplied from the sea by the main circulating pumps, has branches leading to the different parts of the engines and the bearings in the shaft alleys. Located high in each engine hatch is an oil tank for supplying lubricating oil to the main engines. Each tank has a gravity supply pipe leading to the distributing oil boxes on its engine, where the flow of oil to the different working parts of the engine is controlled.

MAIN ENGINE DATA.

Cylinders, H. P., diameter, inches	32½
I. P., " "	53
L. P. (2), " "	61
Stroke of all pistons, inches	48
Piston valves, H. P. (1 each cylinder) diameter, inches	17½
I. P. (2 " ") " "	19
L. P. (2 " ") " "	19
Main steam pipe, diameter at throttle, "	11
Net area of I. P. to H. P. piston, ratio	2.659 to 1
L. P. pistons (2) to H. P. piston, ratio	7.046 to 1

Piston rods, diameter, inches	7¼
axial hole, H. P., inches	1½
I. P., "	3
L.P., "	4⅜
length, feet and inches	9-0
Connecting rods, length center to center, inches	96
diameter, upper end, "	6⅞
lower " "	8
axial hole, H. P., "	1½
I. P., "	3⅜
L. P., "	4⅞
Crank shaft, diameter, inches	16½
axial hole, inches	9½
coupling disc, inches	29½
thickness coupling disc, inches	3¼
coupling bolts (8-each flange), diameter inches	3¼
length forward section, H. P. and F. L. P., feet and inches	14-7½
length after section, I. P. and A. L. P., feet and inches	16-4½
Crank pin, diameter, inches	17½
length, inches	19
axial hole, diameter, inches	10
Crank webs, width, inches	19
thickness, inches	10¼
Thrust shafts, diameter, inches	15½
axial hole, diameter, inches	9½
collars, number each draft	13
length, feet and inches	16-7
diameter, inches	24¼
thickness, inches	2
space between, inches	4
Line shafts, diameter, inches	15½
" axial hole, inches	9½
length, feet and inches	27-0
Stern tube shafts, diameter, inches	16½
" axial hole, inches	9½
length, feet and inches	37-9
Propeller shafts, diameter, inches	16½
" axial hole, inches	9½
length feet and inches	28-5½
Reversing engines, diameter steam cylinder, inches	15
" oil cylinder, inches	7½
stroke, inches	20
Turning engines, diameter steam cylinders (2), inches	7
stroke, inches	5

AUXILIARY MACHINERY.

Main Condensers.—There is one main condenser in each engine room. They are of the horizontal, cylindrical, surface condensing type, with steel shells and composition water heads.

Diameter of shell, inside	6 feet 7 inches
Length over all	15 " 4½ "
Tubes, diameter, outside	⅝ "
thickness, No. 18 B. W. G.	0.049 "
length between tube sheets	13 feet 0 "
number in each condenser	4,878
Cooling surface, square feet, each	10,375

Main Air Pumps.—A main air pump is provided for each main condenser. They are of the Blake, twin-cylinder, vertical, beam, single acting type.

Diameter of steam cylinders (two)	12 inches
" " pump " (two)	30 "
Stroke	18 "

Main Circulating Pumps.— One centrifugal, double-inlet, circulating pump, driven by a compound engine, is furnished for each main condenser. Each pump has a capacity of 12,000 gallons of water per minute at about 265 revolutions. The pumps are arranged to draw from the sea, the main drain, and from the engine room bilge; and discharge through the condenser or directly overboard, through the by-pass in the inlet and outlet condenser head, to the overboard delivery. The suction valves of these pumps are so interlocked that the sea valve and the bilge or drain valves cannot be opened at the same time.

Diameter of steam cylinders	H. P. 11 inches, L. P. 22 inches
Stroke	10 inches
Diameter of pump runner	45 inches
inlet nozzle	18½ inches
outlet nozzle	21 inches

Feed and Filter Tanks.—There is located in each engine room, one combined feed and filter tank, of 5,525 gallons capacity. The filter box is built in the forward upper end of the tank. It consists of three separate compartments, each filled with the filtering material, through which the water from the main and auxiliary air pumps' discharge passes successively before entering the feed tank.

Feed Pumps.—There are four main feed pumps, of the Blake, simplex, vertical double acting, center packed plunger type, two in each engine room. They are arranged to draw water from the feed and filter tanks, and discharge to the main feed line direct or through the feed water heater, and then into the main feed line.

Six auxiliary feed pumps, of the same type as the above, are located one in each fire room. They have suctions from the feed and filter tanks, the sea, the boiler blowpipes, and the drainage manifolds in their own compartment, and discharge into the auxiliary feed line, overboard and into the fire main.

	Main Feed Pumps	Aux. Feed Pumps
Diameter of steam cylinder	13 inches	11 inches
water cylinder	9½ inches	8 inches
Stroke	12 inches	12 inches

Hotwell Pumps.—In each engine room there is one Blake, simplex, vertical, double acting, hotwell pump, having suction connections from the bottom of the main condensers, the reserve feed tanks in the double bottoms, and the filling pipes from the ship's side. These pumps discharge into the feed and filter tanks and into the reserve feed tanks.

Diameter of steam cylinder	12 inches
water cylinder	14 inches
Stroke	12 inches

Distiller Circulating Pump.—There is one distiller circulating pump in the starboard engine room, of the same size and type as the hotwell pumps. This pump has a sea suction and discharges through the distillers and overboard, or into the flushing main.

Fire and Bilge Pumps.—One fire and bilge pump of the Blake, simplex, vertical, double acting type, is located in each engine room. These pumps draw water from the sea, the drainage system, and from the bilges in their own compartment, and discharge into the fire main or overboard.

Diameter of steam cylinder	12 inches
water cylinder	10 inches
Stroke	12 inches

Feed Water Heaters.—A vertical cylindrical feed water heater is located in each engine room, on the discharge side of the main feed pumps. The heating agency is exhaust steam from the auxiliary exhaust line, which enters the shell at the top, circulates around the tubes, and drains at the bottom to the main or auxiliary condensers. The feed water passes through the tubes, from bottom to top. A slight back pressure is kept in the auxiliary exhaust lines, for properly heating the feed water, by adjustable spring relief valves at the connections to the condensers.

Diameter of shell, inside	2 feet 5½ inches
Length over all	10 feet 4 inches

Tubes, number in one heater	683
diameter, outside	⅝ inch
thickness, No. 16 B. W. G.	0.065 inch
length between tube sheets	7 feet 5 inches
Heating surface, each heater, square feet	829

Auxiliary Condensers.—There are four auxiliary condensers, one in each engine room, and one for each dynamo room. They are of the Wheeler surface condensing type, with combined air and circulating pump, of the Blake horizontal, simplex type, attached to and under the condenser.

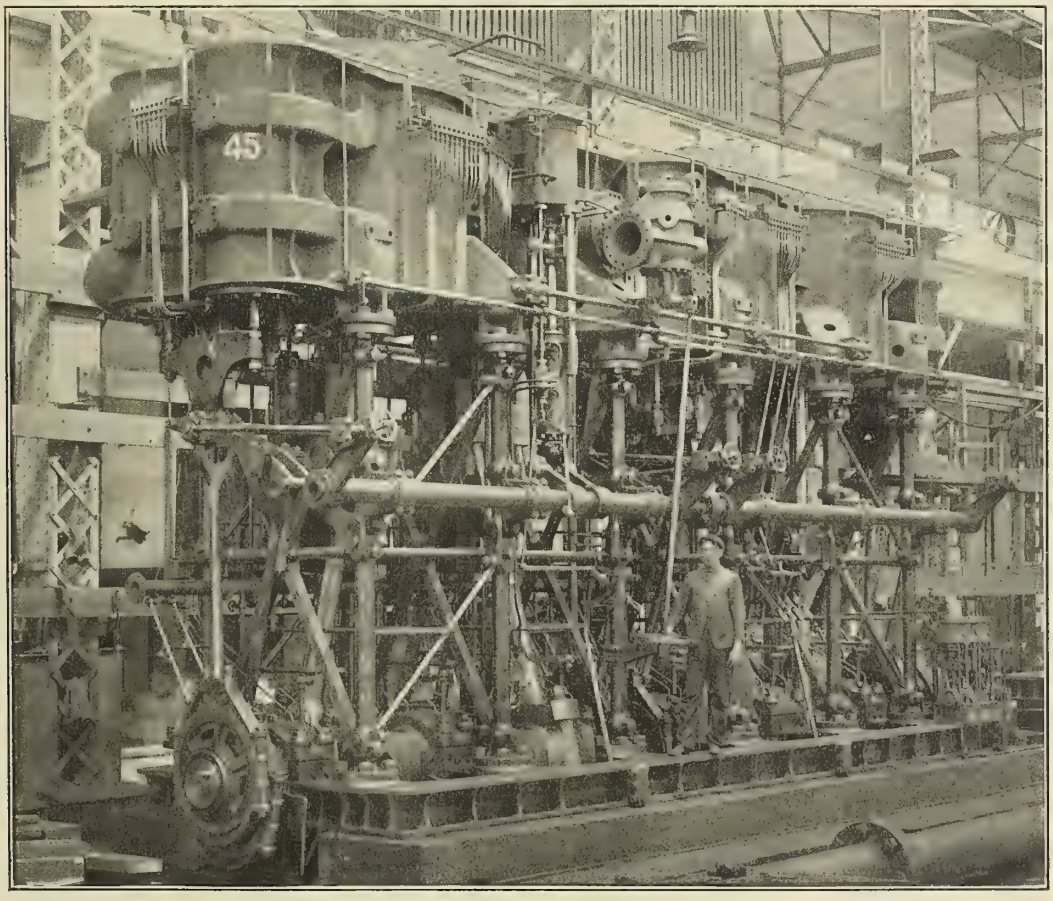
	Engine Room	Dynamo Room
Diameter of shell, inside	2 feet 4 inches	2 feet 7½ inches
Length over all	7 feet 9 inches	8 feet 11¾ inches
Tubes, number, each	518	781
diameter, outside,	⅝ inch	⅝ inch
thickness No. 18 B. W. G.	0.049 inch	0.049 inch
length between tube sheets	6 feet 6 inches	7 feet 7⅛ inches
Cooling surface, square feet, each	551	970

Steam cylinders, diameter	6 inches
Stroke	5 inches
Fan, diameter	66 inches

Ash Hoists.—For the removal of ashes, the ventilator in each fire room is fitted with angle guide strips to facilitate the hoisting of the ash buckets through same, and thence by trolley to the chutes at the ship's side. The hoisting is done by three Williamson Brothers 4½ by 4½ inches reversible ash hoist engines, one located just below the upper deck level immediately above each pair of athwartship fire rooms.

Distilling Apparatus.—The distilling apparatus is on the berth deck just forward of the engine hatches. It consists of three evaporators, of the horizontal straight tube type, two vertical distillers, located in a trunk above the evaporators, and the necessary accessories. The designed capacity of the plant was 16,500 gallons of water per twenty-four hours, which requirement was most successfully met when tested.

	Evaporators	Distillers
Diameter of shell, internal	5 feet 0 inches	18½ inches
Length over all	6 feet 9½ inches	6 feet 11 inches
Tubes, number, each	96	187
diameter, inside	2 inches	⅝ inch
thickness, No. 12 and 16 B. W. G.	0.109 inch	0.065 inch
length between tube sheets	5 feet 5 1/16 inches	5 feet 5 inches
Heating surface square feet, tubes	275	165
Capacity each, gallons per 24 hours	5,500	8,250



STARBOARD ENGINE OF BATTLESHIP LOUISIANA, LOOKING AFT.

Auxiliary Air and Circulating Pumps.—

	Engine Room	Dynamo Room
Diameter of steam cylinder	6 inches	10 inches
air cylinder	10 inches	14 inches
water cylinder	10 inches	16 inches
Stroke	12 inches	12 inches

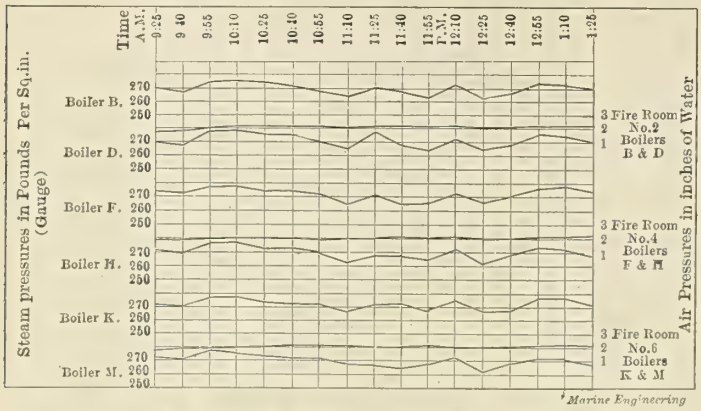
Forced Draft Blowers.—Twelve Sturtevant blowers, located two in each boiler compartment above the boilers, supply the forced draft. The blowers deliver directly into the fire rooms, the closed fire room system being used. The engines are two cylinder, upright and double.

Refrigerating Apparatus.—This plant consists of two 2-ton horizontal Allen dense air ice machines of the latest design and

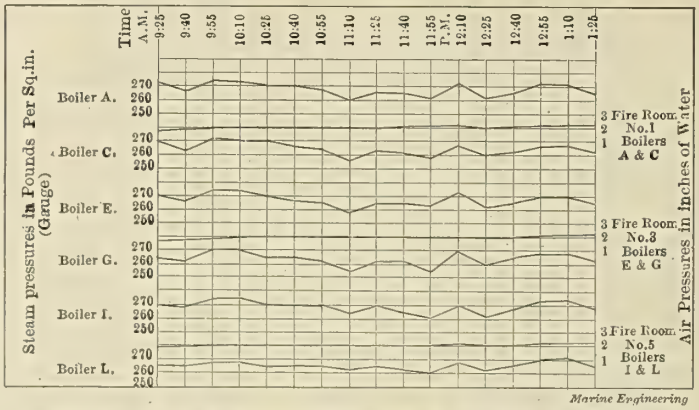
naval practice, supplying cold air to the cold storage rooms, ice making tank, and the scuttle butts. The official test of this plant showed highly satisfactory results.

General Workshop.—Located on the berth deck, between the engine hatches, is the general workshop. All the tools have independent electric driving motors. The following tools are installed: One 36-inch and one 14-inch lathe; one milling machine; one shaper; one 22½-inch drill press; one 12-inch sensitive drill; one double-wheel emery grinder; and bench vises.

An air compressor is installed in the port engine room for running pneumatic tools.



STEAM AND AIR PRESSURES IN PORT FIREROOMS, FOUR-HOUR TRIAL.



STEAM AND AIR PRESSURES IN STARBOARD FIRE ROOMS, FOUR-HOUR TRIAL.

SCREW PROPELLERS.

The two propellers are of manganese bronze and turn inboard when going ahead. They have three blades, and are designed as true screws. The surfaces of the blades are ground smooth with an emery wheel and edges filed sharp. The hub and blades are cast separate, the latter being bolted to the hubs by seven tap bolts each. The bolt holes in the palm of the blades are elliptical to permit of adjusting the pitch. After the pitch has been set the blades are secured against turning, by composition chock pieces fitted in the space between the bolts and the edges of the elliptical holes. The design of the blades is shown in the drawing on page 167.

Diameter of propeller	17 feet	3 inches
hub	4 feet	4½ inches
Pitch, as set	18 feet	0 inches
" ratio to diameter	1.0435	
" variable between	17 feet and 19 feet	
Helicoidal (developed) area, square feet	84.5	
Projected area, square feet	71.5	
Disk area, square feet	233.71	

BOILERS.

Steam is supplied by twelve Babcock and Wilcox water tube boilers of the latest design, arranged, two each, in six comunicating watertight compartments, with athwartship fire room between each two boilers. Each boiler has a horizontal drum across the front at the top. Below the drum and connected to it are the front headers, placed side by side across the front of the boiler, and inclined slightly forward to give the tubes the necessary angle of inclination for proper water circulation. The tubes connect to the front headers, and extend back over the grates to join the rear headers, the latter connecting with the drum through circulating tubes at the top of the boiler. At the sides of the furnaces and in the center, dividing the two, are square water boxes, connected front and back to vertical boxes, which join with the tube sections above. Efficient lagging is provided and the casing is of light sheet steel. Doors are fitted in the side casings to permit cleaning the tubes. All the headers are provided with handholes opposite each tube, or group of tubes, for removing and renewing same. The baffling is so arranged that the gases of combustion have to cross the tubes three times before exit to the uptake. The arrangement of the tube sections and drums, and the method of baffling, are clearly shown in the illustration on page 166.

There are three smoke pipes, 8 feet 3 inches internal diameter, by 92 feet 5 inches high above the grates. Four boilers connect to each smoke pipe.

Floor space, length, each boiler	10 feet	1 inch
width	14 feet	10½ inches
Number of furnaces	two	
Grates, length	7 feet	0 inches
width	6 feet	6⅜ inches
surface, square feet	91.42	
" all boilers, square feet	1,097	
Heating surface, square feet	4,396	
all boilers, square feet	52,752	
Heating surface÷Grate surface	48.09	
Cross section smoke pipe÷Grate surface	0.146	
Number of tube sections in each boiler	25	
Tubes, diameter	2-inch	4-inch
number	786	53
thickness, B. W. G. and inches	No. 8=0.165	No. 6=0.203
Diameter of steam drum	42 inches	
Length of steam drum, external	15 feet	3⅜ inches
Thickness of steam drum	$\frac{21}{32}$ inch	
Working pressure, designed, pounds per square inch	265	

STEAM AND EXHAUST PIPES.

The main steam pipes, of seamless drawn steel, are arranged in two symmetrical systems, one on each side of the center line bulkhead. Each system is independent, except for an 8-inch cross-connection in the engine rooms. Steam is taken directly from the auxiliary steam pipes, through 7-inch branches, and so indirectly from the boilers. These branches from the forward and middle compartments unite in one 9-inch pipe, which is increased to 11 inches where joined by the branches in the after boiler compartment, and this diameter is continued to the engine. A separator is fitted in each system near the engine.

The auxiliary steam pipes take steam directly from the boiler through 5-inch pipe connections, and extend throughout the machinery space, with branches to the main steam pipes, as stated in preceding paragraph, and to all auxiliaries.

An auxiliary exhaust pipe, of copper, is connected to all the auxiliary machinery. It has valves to direct the exhaust steam into either main or auxiliary condenser, either low pressure receiver, either feed water heater, or into the after escape pipe.

OFFICIAL PRELIMINARY TRIALS.

The *Louisiana* left Newport News, Virginia, for Rockland, Maine, on Saturday morning, December 9, 1905, but owing to bad weather she was detained at the mouth of the Chesapeake Bay until the afternoon of the following day. Heavy and thick weather was encountered, and Rockland was not reached until late Tuesday afternoon (12th).

The standardization trial was run on the government measured mile course off Rockland, on Wednesday morning, December 13. The weather was fine and clear, with a smooth sea. Twelve progressive runs were made over the course, the data obtained being tabulated here. The curves, page 168, are plotted from this data.

From the results obtained, 119.1 revolutions per minute of the main engines was found to be necessary to make the contract

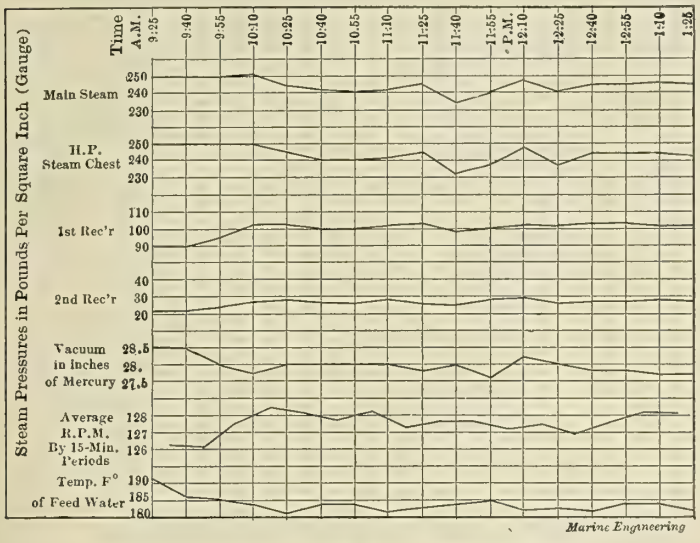


CHART OF STARBOARD ENGINE DATA, FOUR-HOUR TRIAL.

speed of 18 knots. The progressive runs were highly satisfactory, as a glance at the table and curves will show, and gave positive assurance that the speed, on the four-hour run, would easily exceed the requirement.

FOUR HOURS' TRIAL.

The following day was selected for the four-hour trial. It was run at sea, between Rockland and Boston. Fine weather and a smooth sea were again encountered, and an average speed of

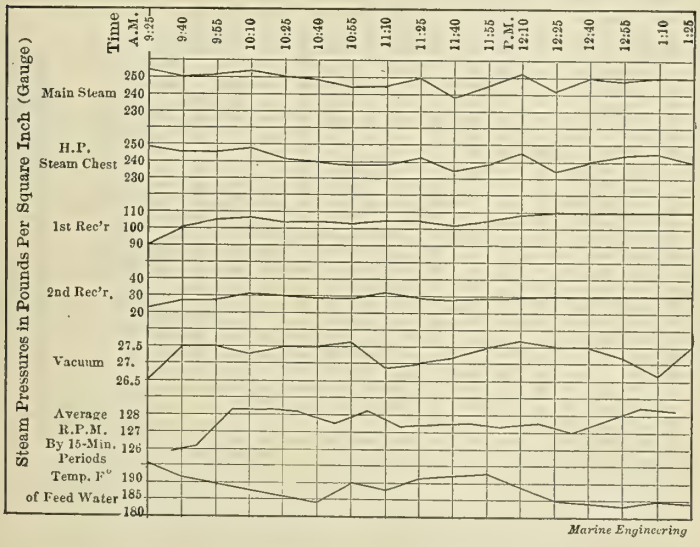


CHART OF PORT ENGINE DATA, FOUR-HOUR TRIAL.

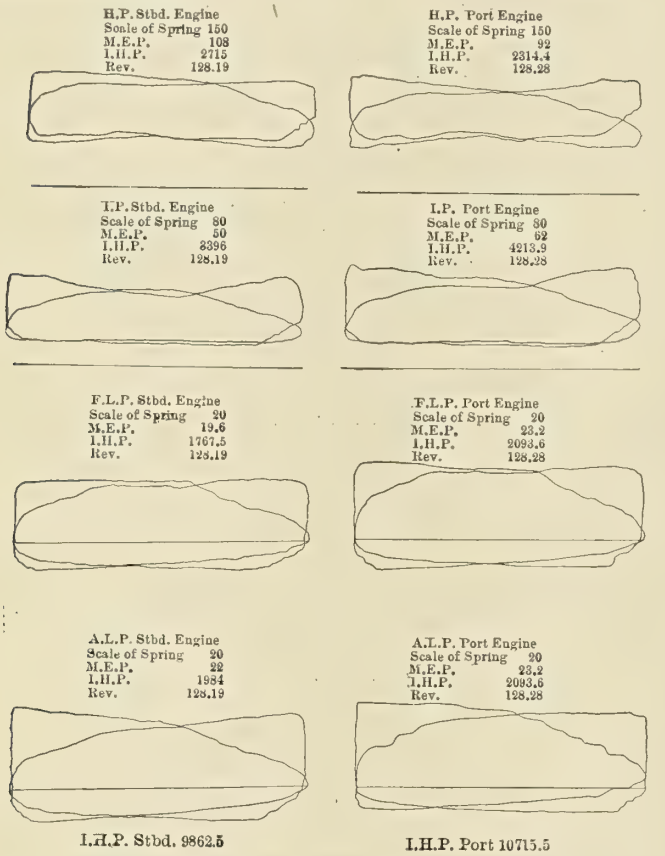
18,823 knots was maintained for the four hours. The revolutions averaged 127.67 per minute, and the engines developed 20,442.5 indicated horsepower. The operation of the machinery plant during this run was of the highest order, and the results of the trial were most gratifying to all concerned.

A set of indicator cards taken during the four-hour run is reproduced. On pages 172 and 173 are shown graphically the variations in the steam pressures, etc., throughout the run. The data obtained follows.

U. S. S. LOUISIANA. DATA FROM STANDARDIZATION RUNS ON MEASURED MILE OFF ROCKLAND, MAINE, WEDNESDAY, DECEMBER 13, 1905.

Number and Direction of run	Time on Course Min.	Time on Course Sec.	Which Engine	REVOLUTIONS OF MAIN ENGINES: To Make One Knot	REVOLUTIONS OF MAIN ENGINES: PER MINUTE	REVOLUTIONS OF MAIN ENGINES: PER MINUTE Average	Speed in Knots	INDICATED HORSEPOWER: MAIN ENGINES H. P. Cyl.	I. P. Cyl.	F. L. P. Cyl.	A. L. P. Cyl.	Total	Total Both Engines	Auxiliaries in Operation	Total All Machin'ry	STEAM PRESSURES: GAUGE In Boilers	GAUGE At Eng.	ABSOLUTE H. P. St'm. chest	ABSOLUTE 1st Rec'r	ABSOLUTE 2nd Rec'r	MEAN EFFECTIVE PRESSURES H. P. Cyl.	I. P. Cyl.	F. L. P. Cyl.	A. L. P. Cyl.	Referred to L.P. Cyls.	Vacuum in Inches	Air Pressure in Inches of Water	CUT-OFF IN CYLINDERS H. P.	I. P.	F. L. P.	A. L. P.
1-S	3-14.1		S	402.2	124.23	123.78	18.547	2972	2895.8	1607.9	1660.3	9136		713.2		263.2	248	250	105	36		44		18.4		52.2	26.5	1.09	F. G.	FULL GEAR	FULL GEAR	FULL GEAR
			P	399.25	123.33											263.2	250	255	100	32							26.6					
2-N	3-14.45		S	403.35	124.98	124.96	18.514	2990.2	2079.7	1617.7	1758.4	9346	18548.8	817.4	19366.2	270.9	250	260	105	36		122		18.4		53.16	26.8	1.31	F. G.			
			P	403.2	124.93			2891	2998.5	1669.8	1643.5	9202.8				270.9	252	260	102	32.7		118		19		52.36	26.6					
3-S	3-14.47		S	404.85	124.89	124.68	18.512	2988	2858.5	1581.4	1704.4	9132.3	18351.5	775.2	19126.7	268.5	250	257	105	36		122		18.4		51.98	26.6	1.30	.76			
			P	403.45	124.46			2928.9	3033.3	1637.3	1619.7	9219.2				268.5	255	257	101	32.5		120		18.7		52.64	26.7		.76			
4-N	3-13-4		S	405.55	125.43	125.38	18.614	3050.2	3023.7	1623.5	1720.6	9418	18840.5	752.5	19593.0	273.5	255	262	105	37.5		124		18.4		53.36	26.2	1.35	.76			
			P	405.2	125.32			2973.8	3107.4	1701.5	1639.8	9422.5				273.5	260	265	105	33		121		19.3		53.44	26.7		.76			
5-S	3-10.25		S	401.6	126.49	126.32	18.922	3150.3	3082.9	1619.5	1824.2	9676.9	19315.1	783.9	20099.0	282.3	265	270	106	38		127		18.2		54.37	26	1.36	.76			
			P	400.5	126.14			3067.4	3101.1	1668.3	1801.4	9638.2				282.3	270	272	106	34		124		18.8		54.3	26.6		.76			
6-N	3-17.3		S	402	122.38	122.56	18.246	2940	2788.1	1394.7	1635.7	8758.5	17647.4	654.3	18301.7	268.2	250	255	97	35		122.5		16.2		50.87	26.4	1.09	.735			
			P	403.2	122.74			2895.6	2893.7	1528.2	1571.4	8888.9				268.2	255	257	98	31.5		120.3		17.7		51.51	26.6		.735			
7-S	3-17		S	391.75	119.32	119.34	18.274	2796.3	2282.1	1267.5	1418.6	7764.5	15826.1	604.6	16430.7	256.9	235	245	85	31		119.5		15.1		46.25	27.5	.91	.675			
			P	391.85	119.35			2820.4	2529.3	1351.7	1360.2	8061.6				256.9	245	250	87.5	27.5		120.5		16.1		48	26.8		.675			
8-N	3-31		S	400.35	113.79	114.37	17.062	2800.5	2073.9	1024.6	1120.7	7019.7	13990.8	555.2	14546.0	259	242	255	73	26		125.5		14.8		43.84	27.8	.83	.56			
			P	404.45	114.96			2615.3	2131.8	1091.8	1132.2	6971.1				259	245	258	77.5	24		116		13.5		43.1	27.5		.56			
9-S	3-26.5		S	379.1	110.05	109.97	17.433	2589.8	1795.8	882.6	983.2	6251.4	12361.4	449.4	12810.8	252	240	251	65	24.2		120		11.4		40.38	27.6	.40	.5			
			P	378.55	109.89			2553.9	1793.4	850.4	912.3	6110				252	245	257	56	20.4		118.5		11		39.51	27.6		.5			
10-N	3-47		S	397.9	105.24	105.18	15.859	2318.6	1589.1	718.1	762.6	5388.4	10551.2	303.1	10854.3	256.4	245	242	60	21.5		107.5		9.7		35.71	27.9	.08	.5			
			P	397.45	105.12			2226.4	1487	732.1	717.3	5162.8				256.4	240	240	55	17		108		9.9		34.89	27.5		.5			
11-S	3-35.3		S	379.1	103.05	102.66	16.721	2122	1446.9	717.7	775.7	5062.3	9760.3	293.8	10054.1	270.4	260	240	55	20.3		105		9.9		34.92	27.7	.03	.5			
			P	367.25	102.26			2005.5	1354.5	654.6	683.4	4698				270.4	262	237	54	16.7		100		9.1		32.65	27.1		.5			
12-N	4-13.8		S	396.35	93.81	93.62	14.184	1508.5	1093.7	494.9	521.4	3618.5	7113.5	297.1	7410.6	253.8	245	245	45	16.5		82		7.5		27.38	27.8	.02	.5			
			P	394.75	93.43			1502	1040	479.8	473.2	3495				253.8	252	200	44	15.5		82		7.3		26.59	27.3		.5			

	Starboard	Port
Steam pressure at boilers (gauge)	270.4	
engine room (gauge)	243.5	247
H. P. steam chest (gauge)	242.1	236.5
1st. Receiver (absolute)	114	119
2d. " (")	40.9	44.7
Vacuum in condensers, inches of mercury	26.5	26.5
Revolutions of main engines (mean)	127.66	127.69
average for both	127.675	
circulating pumps	162.3	148.8
blower engines, average	517	
Double strokes of main air pumps	21.5	21.9
main feed pumps	28.25	30.25
fire and bilge pumps	66.7	61.5
auxiliary condenser, air and circulating pump	30	
Speed of ship, knots	18.823	



INDICATOR CARDS FROM OFFICIAL FOUR-HOUR TRIAL.

Slip of propellers, in percent of their own speed, based on mean pitch	16.99	17.01
Air pressure in five room, inches of water	1.98	
Mean effective pressures, main engines:		
H. P. cylinder	108.2	99.4
I. P. "	49.6	57.3
F. L. P. "	19.8	23.8
A. L. P. "	22.4	23.4
Mean equivalent pressure in pounds per square inch referred to combined area of L. P. pistons,	54.85	59.04
Indicated horsepower, main engines:		
H. P. cylinder	2,707.1	2,485.5
I. P. "	3,349.9	3,873.1
F. L. P. "	1,780.3	2,138.4
A. L. P. "	2,006.9	2,101.3
Total	9,844.2	10,598.3
Total, both main engines	20,442.5	
Main air pumps	12.25	12.62
Circulating pump engines	48.5	38
Main feed pumps	94.5	99.2
Fire and bilge pumps	15.2	13.6
Auxiliary condenser, air and circulating pump	1.9	
Blower engines	444	
Dynamo engine (1 100-Kw. dynamo)	128.2	
Total auxiliary machinery	907.97	
Total all machinery in operation	21,350.47	
Coal, kind and quality	New River, hand picked	
pounds per hour	42,112	
" " square foot of G. S. per hour	38.39	
" " " " " H. S. " "	0.798	
" " I. H. P. per hour of all machinery in operation	1.973	
I. H. P. (total) per square foot of G. S.	19.46	
" (") " " " " H. S.	0.4047	
Temperature, atmosphere, degrees F.	34.5	
Engine rooms, upper platform	88.9	
lower "	71.3	
Fire rooms, above grating	66.8	
working level	64.5	
injection water	42	
overboard delivery	113.9	
hotwell, maximum	116	
minimum	92	
average	101.6	
main feed, maximum	194	
minimum	180	
average	185.3	
smoke pipes, base, maximum	650	
minimum	550	
average	598	

STABILITY CALCULATIONS BY PLANIMETER.

BY R. E. ANDERSON.

In designing small sailing craft and launches, the investigation of their stability is frequently neglected because of the length of time required for the arithmetic computation, and the cost of the integrator whereby the stability is more rapidly determinable. This has led the writer to propose the method which is discussed herein, and which requires a planimeter of the least expensive type, the instrument used in the preparation of this paper being one with a fixed arm. The principle upon which the method is based is the familiar property of the curve of displacement, although it is applied in a special manner.

Suppose Fig. 1 to represent a ship and *K D* its curve of displacement. That is, *K D* is a curve so constructed that each ordinate represents by its length the displacement of the vessel when immersed to the corresponding water line. If now, with the ship floating at the water line *W L*, we measure the area of the curve of displacement up to *W L*, that is, the area *C K A*, and divide it by the length of its final ordinate *C A*, we get a value which being measured down from *C* gives *B*, the center of buoyancy.*

But this property of the curve of displacement is in no wise dependent on the solid's being a ship's form, nor on the vertical immersion of the solid. Let Fig. 2 represent any solid. Now ridding ourselves entirely of the idea of immersion, let us suppose that the curve *W T* represents, by the ordinates as measured from *L W*, the successive *volumes* which would be cut off by planes *ab, cd, ef*, etc. Then if we measure the area of the curve *L W T* and divide it by the ordinate *L T*, we get the value *L B*, which measured from *L* gives the distance that the center of gravity is from the tangent plane *N M*. This locates, not the center of gravity in the direction of *N M*, but only its distance from the plane.

*See Attwood's Theoretical Naval Architecture, Appendix A, for proof.

Returning now to a ship shaped form, Fig. 3, and taking the ship inclined at an angle, we are interested only with the part *W L K* which is below the water line, and this may be considered simply as an irregular solid like Fig. 2. We can then construct a curve *W T*, which will represent by its ordinates as measured from *W L* the successive volumes cut off by the planes *ab, cd, ef,* etc. Then by measuring the area *W L T* of this curve, and dividing it by the last ordinate *L T*, we get the distance *L B* that the center of gravity of this solid is from the plane *L M*. But by taking the line *L M* and the various planes *ab, cd, ef,* etc., all perpendicular to the water line *W L*, what we really get is the location of the vertical line through which the buoyancy of the vessel acts. And if we know the position of *G*, the center of gravity of the vessel, we can at once measure *G Z*, the righting lever.

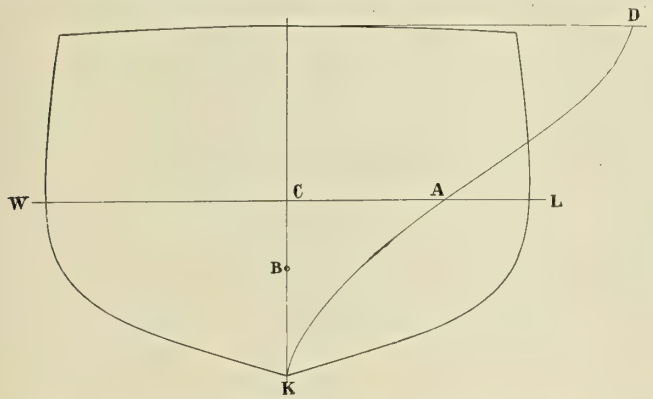


FIGURE 1.

In the practical application of this principle to the stability calculation, use is made of the Tchebycheff rule for three ordinates. (See paper by Professor Biles in the *Transactions of Institute of Engineers and Shipbuilders in Scotland* for 1899.)

In Fig. 4, to find the area of the curve *A B C D*, erect an ordinate bisecting the base and two other ordinates each distant from the middle ordinate $\frac{1}{2} l \times \frac{1}{2} \sqrt{2}$. The area of the figure is the sum of these three ordinates, multiplied by the length of the base, and divided by the number of ordinates, or $A = \frac{l \Sigma}{n}$. It will be seen that any number of ordinates may be obtained by dividing the base up into equal parts and applying this rule for the three ordinates to each part. The summation of ordinates does not have to be made separately.

The particular advantage of the Tchebycheff rule for our work lies in the fact that the simple sum of the ordinates is required, not the sum of functions of ordinates as in Simpson's rule; and if we have a body plan with sections spaced according to the Tchebycheff rule we can obtain the volume displaced up to any given water line by simply going over the sections successively with the planimeter. The instrument does the adding for us, and all that is necessary is to read the final area, multiply it by the length of the ship, and divide it by the number of sections This facility of adding the ordinate areas with the planimeter itself is of especial importance in constructing curve *W T* of Fig. 3.

The practical performance of the calculation will be best understood by following an actual case. The ship used as an example is a torpedo boat destroyer, 240 feet long, 23 feet beam, 14 feet 6 inches deep, and 7 feet 9 inches draft, displacing 564 tons.

The first operation is the construction of a Tchebycheff body plan. We decide to apply the rule three times, thus obtaining nine ordinates. The length is therefore divided into three parts, *Sa, ab,* and *bB*, Fig. 5, and to each of these parts the rule for three ordinates is applied by the following graphical method: *Sa* is bisected at *c*, *ab* at *d*, and *bB* at *e*. Now with *ca* as hypotenuse, a right angle triangle is constructed having two legs *cg* and *ag* equal.

Now $cg = ca \cdot \frac{1}{2}\sqrt{2}$ and since $ca = \frac{1}{2} l$, we have the required distance, $\frac{1}{2}l \times \frac{1}{2} \sqrt{2}$ to be laid off each way from each middle ordinate. Laying off this distance *cg* then each way from *c, d,* and *e,* we have the positions of the nine ordinates. It should be noted that *a, b,* and *c,* are not positions of ordinates but only the points of division between the successive applications of the rule, and are therefore discarded.

The body plan is now drawn in accordance with this spacing of sections. It is necessary to draw the sections for both sides of the ship, and it is convenient to show the sections of the after body either in red ink or in dotted lines.

The planimeter is now set with its index at zero and the tracing point resting at *a* (Fig. 6). The tracing point is then moved to the right along the water line *W L* until it meets section No. 1, which it follows around to the water line again; then it is moved to the right along *W L* until it meets section No. 2, which it traverses back to the water line. This is continued until all the sections have been traversed, and the tracing point again rests at *a*. The area of each section traversed is thus added by the instrument to that of the preceding sections, and the final reading, when corrected for scales, is the sum of the areas of the sections.

In our example this final reading was 184.95; as the instrument recorded only up to 100 the actual reading was 84.95, but the 100 mark had been once passed. Throughout this planimeter calculation this is a point to be watched, and the reading of the wheel should be roughly noted several times while taking a sum of areas.

Our instrument recorded actual square inches, and as the drawing was to a scale of one-half inch to the foot, each square inch represented four square feet. The real sum of the areas

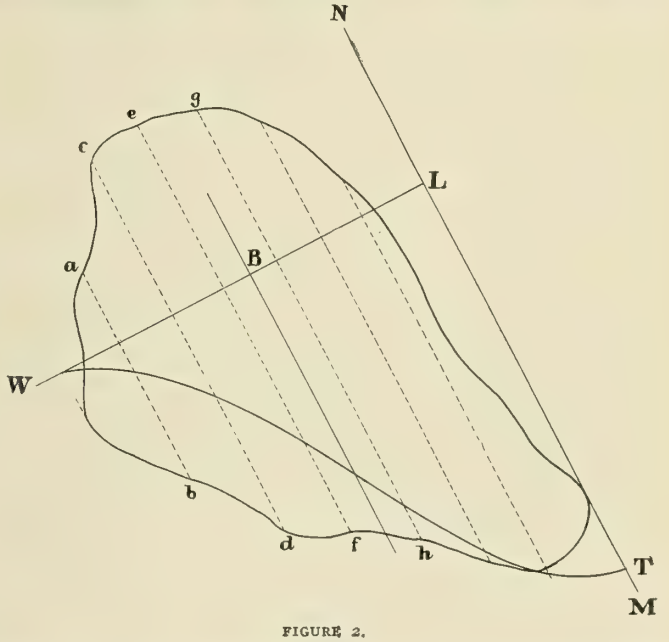


FIGURE 2.

of the sections was therefore 4 × 184.95, or 739.8 square feet. The length of the ship being 240 feet and there being nine ordinates, the multiplier according to the Tchebycheff rule is $\frac{240}{9}$. The displacement is therefore $\frac{184.95 \times 4 \times 240}{9} = 19{,}728$ cubic feet, which, divided by 35, gives 564 tons.

We have carried this matter of displacement through to a result in tons because it is a useful check if the displacement has been separately calculated by other means, and is desired as a result if it has not been previously calculated. In the stability calculation itself however, we work, not with the tons displacement, but with the original number obtained with the planimeter,

184.95, which represents simply the planimeter reading corresponding to the displacement.

We are now ready to incline the ship to a series of angles and determine the value of the righting lever for each angle. In our example we have inclined the ship to 30°.

The first problem is to find the true water line. For this purpose we draw in pencil a trial water line as nearly in its correct position as our judgment will allow, and with the planimeter take the sum of the areas of the sections below this trial water line. In Fig. 6, *wl* was the water line so chosen, and the final reading of the planimeter was 190.32; it should have been 184.85, so that this trial line is too high. A second trial line *w'l'* is drawn. It is convenient to make the trial lines some even distance apart, and in this case we chose 0.2 inch. The area below w'l' is now measured. In the example the reading was 175.64, which is too low.

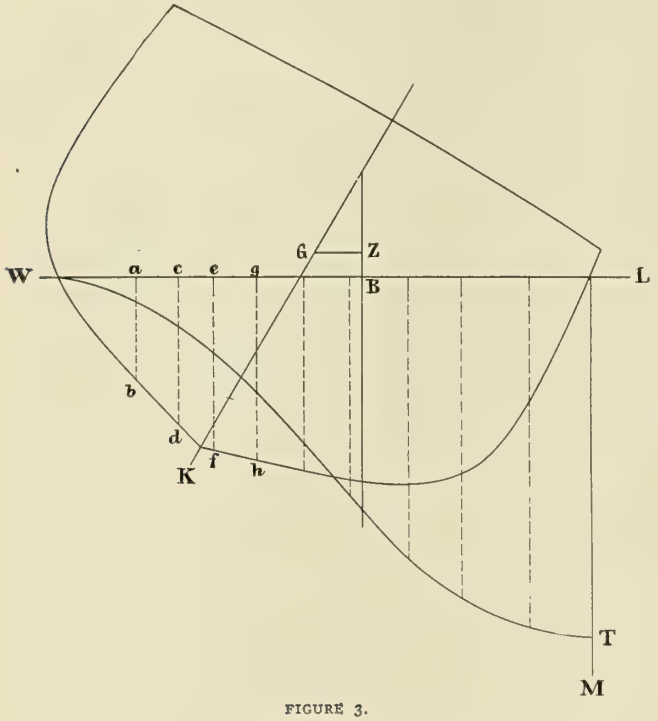


FIGURE 3.

The true water line evidently lies between the two trial lines, and it may be located by a simple proportion, since the trial lines are near enough together to make any error inappreciable. The difference between the true reading and the reading up to *wl* was 190.32 — 184.95 = 5.37; the difference between the true reading and the reading up to *w'l'* was 184.95 — 175.64 = 9.31. If then we call *d* the distance between *wl* and *w'l'*, and the distance between *w'l'* and the true water line, *x*, we have *x*: (*d*—*x*) = 9.31: 5.37. Putting in for *d* its true value 0.2 and solving, we have *x* = 0.127 inch.

The true water line *W'L'* may now be drawn in pencil 0.127 inch above *w'l'*. Testing this with the planimeter, the water line *W'L'* was found to give the correct reading within about one-tenth of one percent. If both trial lines had given too great a reading, or if both had given too small a reading, a proportion is easily established to suit the case. The error due to the use of such a proportion will of course depend on the distance between the trial lines, and their distance from the true water line.

A straight line is now drawn in ink on a piece of tracing paper, with a series of lines perpendicular to it. These perpendiculars may be any distance apart and the spacing need not necessarily be even. This tracing paper is then placed over the body plan with the straight line first drawn covering the true inclined water line, and the last perpendicular touching the farthest immersed point of the body plan, as shown at *i*, Fig. 6.

The planimeter is now set at zero with the tracing point resting at *b*. The tracing point is now made to travel to the right from *b* to *k*, to *r*, to *b*; thence to *m*, to *n*, and back to *b*, and so on, traversing in turn that part of each section which lies to the left of the *b* perpendicular and below *W'L'*. The final reading of the planimeter is now set upon the *b* perpendicular from *W'L'* as a base, using any convenient scale. In the example the reading was 5.07, and the scale selected was the 20 scale, so that one-half inch of ordinate represented 10 units of planimeter reading.

The area below *W'L'* and to the left of the *c* perpendicular is now found, and the reading set up to the scale. This is done for each perpendicular, so that each ordinate represents the total area below *W'L'* and to the left of itself. The integral curve *ps* is now carefully drawn in pencil, observing that it will come in tangent to *W'L'* at *p*, and perpendicular to *si* at *s*.

In obtaining the areas up to the successive perpendiculars, a very useful triple check may be had with very little extra work. If, when the area to the left of *b* has been obtained, the planimeter be not reset, but made to traverse the sections lying between the perpendiculars *b* and *c*, the effect will be to add this included area to that already obtained for *b*, and the final reading will be the area up to *c*. Moving the planimeter now to *c*, and setting it at zero, the total area to the left of *c* is separately obtained, and should check that previously found by the instrumental addition. The instrument is then used to add to the *c* area the area between *c* and *d*, when it is moved to *d* and the *d* area obtained separately; and so on for all perpendiculars.

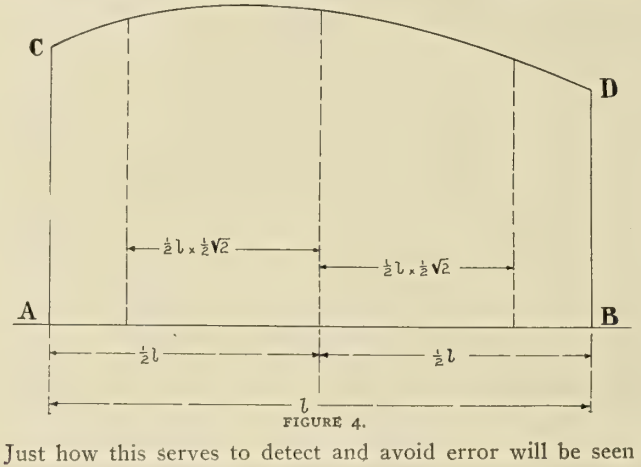


FIGURE 4.

Just how this serves to detect and avoid error will be seen by observing the results which were obtained in the example, and which are presented below:

PLANIMETER READINGS.

up to *b*	5.07	
adding between *b* and *c*	20.84	
up to *c* separately	20.82	
adding between *c* and *d*	58.27	
up to *d* separately	58.25	
adding between *d* and *e*	96.55	?
up to *e* separately	96.62	
adding between *e* and *f*	134.23	
up to *f* separately	134.23	
adding between *f* and *g*	161.65	
up to *g* separately	161.82	?
adding between *g* and *h*	179.73	?
up to *h* separately	179.54	
adding between *h* and *i*	185.12	
up to *i* separately	184.95	

It will be observed that, except in the three cases marked with interrogation points, the agreement was within one-tenth of one percent.

For the *e* perpendicular, however, the results did not check; so we continued to the *f* perpendicular, where the results did

check. It was safe to conclude that both results for *f* were virtually correct, and as one of them was obtained by adding to the independent *e* result, the inference was that the result "up to *e* separately" was correct, and that the value 96.55 was in error.

For the *g* perpendicular there was disagreement, and also for the *h* perpendicular. But for the *i* perpendicular there was virtual agreement (the error being less than one-tenth of one percent). So we accepted the 179.54 reading for *h*, because the correct sum reading for *i* was dependent on it. Having decided that the summation reading for *h* was wrong, and as this depended on the reading "up to *g* separately," which also disagreed with its mate, the inference was that the " up to *g* separately" reading was also wrong, and the figure 161.65 was consequently accepted as correct for *g*. It will thus be seen that this system of checking not only detects any error but shows at once which is the correct figure.

The area of the integral curve is now obtained in *actual square inches*. In our example this area was 51.7 square inches. This is now divided by the last ordinate, *si*, in actual inches (9.256 inches in this case) so that we have $\frac{51.7}{9.256} = 5.59$ inches, which is to be measured back in actual inches from *i* on *W'L'*, giving a point through which the perpendicular *ZB'* is drawn. This is the required perpendicular through the center of buoyancy, and if the center of gravity of the ship be assumed to be at *G*, then *GZ* is the righting lever, and may be directly measured and transferred as an ordinate of the curve of statical stability, the other ordinates of which are obtained by repeating the process for various angles of inclination.

In proceeding to a new angle, the same piece of tracing paper may be used with its inked-in set of perpendiculars, and the pencilled curve on it may be erased. We can, however, avoid the necessity of going through the process for the smaller angles of inclination by application of the property of the tangent to the stability curve. If from this origin a straight line be drawn tangent to the curve of righting levers, this tangent will, at the point corresponding to 57.3° inclination, intercept an ordinate which is equal (to scale) to the metacentric height. If then we know the metacentric height we can set this up at 57.3°, draw the tangent line down to the origin, and thus obtain at once the slope of the curve at the origin. Using this tangent line as a guide it will be found that it is not necessary to obtain points for the smaller angles of inclination.

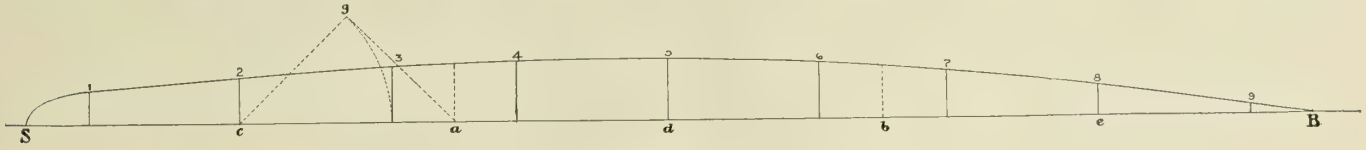


FIGURE 5.

To obtain the metacentric height it is necessary first to know the position of the center of buoyancy in the upright position. This can be found by constructing the ordinary curve of displacement, performing the integration with the planimeter between horizontal water planes up to the load water line. It is necessary to integrate only one side of the ship. Then, taking the area of the curve of displacement, and dividing by the load water line ordinate, we have the distance of *B*, Fig. 6, below the load water line. It is of course on the vertical center line.

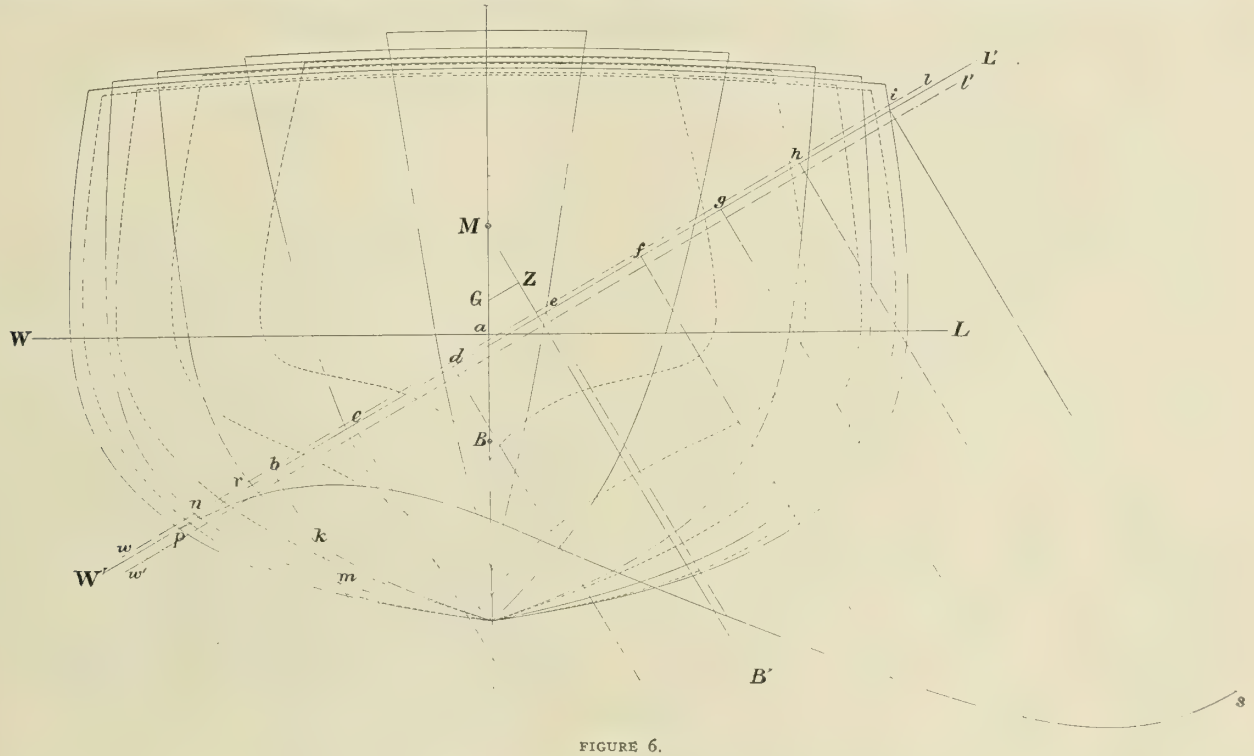


FIGURE 6.

We now obtain the *BM* arithmetically. With information already at hand this is very simple. We measure the half ordinates of the load water plane as given on the Tchebycheff body plan, keeping the measurements in actual inches; then cube each half ordinate, add the cubes, and take two-thirds of the sum. Dividing this by the square inches reading of the planimeter, which was obtained in the beginning as corresponding to load displacement, we have the metacentric height to the same scale as the drawing—that is, we have a distance which, measured up from *B*, Fig. 6, in actual inches, gives *M*, the transverse metacenter.

Thus in the ship used for illustration, the sum of the cubes of the half ordinates was 819.24; the original reading of the planimeter for load displacement was 184.95; we have therefore

$\frac{2}{3} \cdot \frac{819.24}{184.95} = 2.95$. This is of course the ordinary formula $BM = \frac{I}{V}$. Tchebycheff multipliers cancel out and leave the formula in the simplified form given.

We now have M, and it remains only to measure GM on our drawing and transfer it to the curve of righting levers drawing, erecting it from the point on the base which represents 57.3°, and drawing the tangent line to the origin.

The selection of the angles at which to incline the ship will of course depend on the type of the ship. In general the calculation should be performed for the angle at which the deck edge begins to be immersed, for several smaller angles, and for one or two greater angles.

After the curve of righting levers has been plotted, it will probably be found that the maximum stability does not occur exactly at one of the angles for which we have made the calculation. The curve as we have plotted it, however, will give with a reasonable degree of closeness the angle at which the maximum

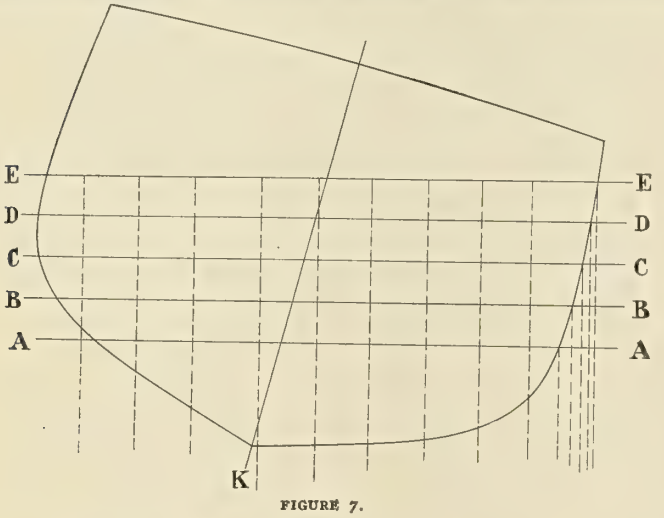


FIGURE 7.

stability does occur, and we can then locate the water line corresponding with that angle, and, performing our calculation for that water line, check the value of the maximum righting lever. The same may be done for the point at which the curve crosses the base—that is, the point at the extreme range of stability.

CROSS CURVES OF STABILITY.

Although the ordinary curve of statical stability is often all that is required, cross curves of stability can easily be directly determined by the same method, and if the ordinary curve is also desired it can be plotted from the cross curves. The cross curves require only a little more work to obtain by this method than does the ordinary curve, and this is more than offset by their greater usefulness.

Let Fig. 7 represent our Tchebycheff body plan. We cover it with a piece of tracing paper and draw, at the first of our series of angles, which is, say, 15°, a series of water lines, *AA*, *BB*, *CC*, etc. They may be at any convenient distance apart, and need not be evenly spaced. They should, however, be so located that one or two will be above the probable location of the inclined load water line, and two or three below it. The perpendiculars are now so drawn that there is one perpendicular from each water line at the point where it leaves the body plan on the immersed side. The other perpendiculars are spaced at will.

We now consider the ship as immersed to *AA*, and perform the calculation as outlined above, drawing the integral curve, taking the area and dividing by the last ordinate, thus obtaining the vertical through the corresponding center of buoyancy. This last ordinate, when corrected for the scales of the drawing and of the planimeter, gives of course the displacement up to *AA*. If we know *G*, the center of gravity of the ship when floating at *AA*, we can measure *GZ*, and so locate a point on the 15° cross curve which will correspond to whatever displacement *AA* gives.

In like manner we integrate up to *BB*, *CC*, etc., and find *GZ* for each. We can then draw in the 15° cross curve, and proceed to the next angle of inclination.

But *G* is not in the same position for all the different conditions of loading which would result in the differing displacements. To overcome this difficulty we must either calculate or assume the position of *G* for each of a series of displacements, and from this data plot a curve giving the height of *G* above the keel for varying displacements. From this curve we can locate *G* for the displacements corresponding to *AA*, *BB*, etc., respectively, and so are able to measure *GZ*. This curve once constructed, answers for all angles of inclination, since the position of *G* is quite independent of the angle.

English and American Capstans and Electric Winches.

BY FRANK C. PERKINS.

Electric winches and capstans are not only utilized on harbor wharves for hauling ships, but are also employed to haul freight cars or heavily loaded trucks into and out of machine shops and other factory buildings, as well as to drag heavy material along the ground upon rollers instead of trucks. The accompanying illustration, Fig. 1, shows the general design and construction of an English capstan and controller for the same installed at Heysham harbor at Lancashire, England, for the Midland Railway Company; though this particular equipment was constructed for the Japanese government and is of a much larger capacity, being capable of hauling ten tons without difficulty, a larger motor and heavier gears being utilized with a corresponding larger capstan

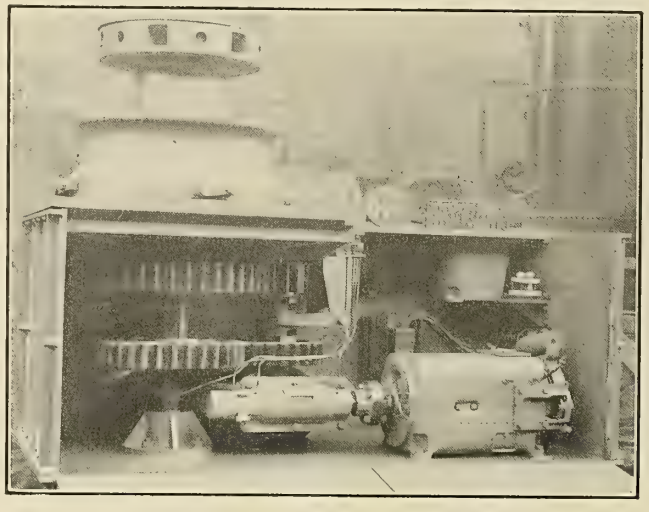


FIG. 1. ENGLISH TEN-TON ELECTRIC CAPSTAN FOR JAPAN.

box. Twelve of these electric capstans were erected at Heysham harbor wharf by Stothert & Pitt, Limited, of Bath, England. The electric motors were constructed by the British Westinghouse Company.

Figures 3 and 4 give two views of an American electric capstan or electric winch constructed by the Sprague Electric Company, of New York city, and designed to haul heavy loads short distances at slow speeds. This electric capstan will pull 1,200 pounds at a speed of 10 feet per minute, and by extending the base so as to completely inclose the motor, the apparatus can be made portable if so desired.

The capstan is equipped with a 20-horsepower compound-wound motor and starting gear of special design, a pedal gearing being arranged for controlling the same. At Heysham harbor there are two one-ton capstans and two three-ton capstans, the latter being

used for hauling ships and the former for ordinary work. On account of the pedal arrangement for starting the capstans in operation and stopping the same, a more or less difficult feature presented itself in arranging the overload cut-out and starting switch. The arrangement of the controller resistances and motor within the capstan box, as well as the driving gear, is clearly seen in the accompanying drawing, Fig. 2, and illustration, Fig. 1.

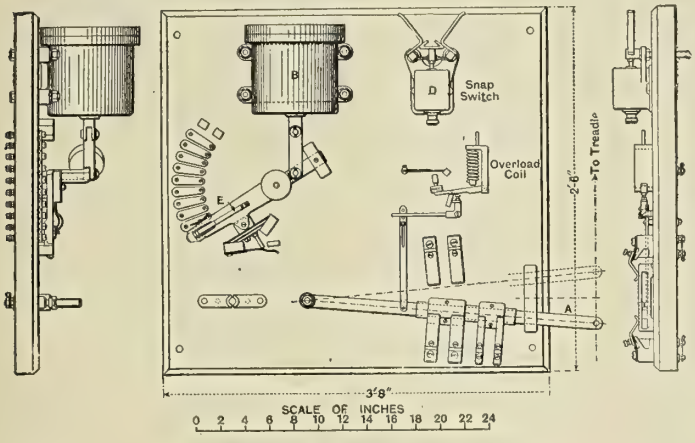


FIG. 2. ELECTRIC CAPSTAN CONTROLLER.

It will be noted that the motor is so arranged in the capstan box that its shaft is horizontal, operating through a bevel gear an intermediate vertical shaft which is connected to the capstan head by means of a single reduction spur gear. Fig. 2 shows the controller itself, which is placed within the capstan box and worked by means of the foot plunger; the lever *A* being depressed by the treadle, thereby connecting the positive main to the coil *B*. The

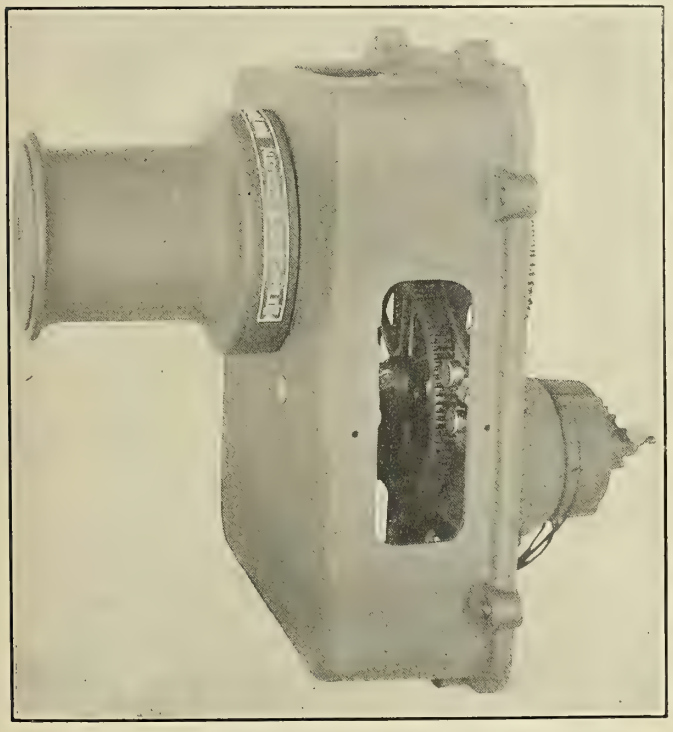


FIG. 3. SPRAGUE HEAVY DUTY ELECTRIC WINCH.

same lever closes the circuit of the coil of the switch *D* by means of two contacts. As switch *D* rises and makes contact, the circuit of coil *B* is completed with the main circuit on the negative side. The starting switch lever is then moved by the coil *B*, and the motor is immediately started. As soon as the lever of the starting switch leaves the two contacts and moves from the "off" position, a resistance is placed in the circuit of the snap-switch coil and the contacts are opened, which operate to short-circuit the lamp resistance when reaching the "on" position. Heating is thus prevented and the current consumption reduced. By making all the connections to the negative main all the sparking takes place at the contacts of the snap switch *D*, and these can be replaced without difficulty. The main contacts on lever *A* break afterward, as the subsidiary contacts which make its circuit are short, and a double pole brake is provided in this way. The main current passes through the overload coil, the resistance of the starting switch being on the positive side before coming to the contact, and in case the load on the electric winch is too great the circuit is opened by the overload coil, and the overload cut-off is held in the off position until the foot plunger is released by a catch. In case there is a heavy overload and the electric capstan comes to a dead stop the operator has only to find out the difficulty, remove the obstruction, and then depress the treadle

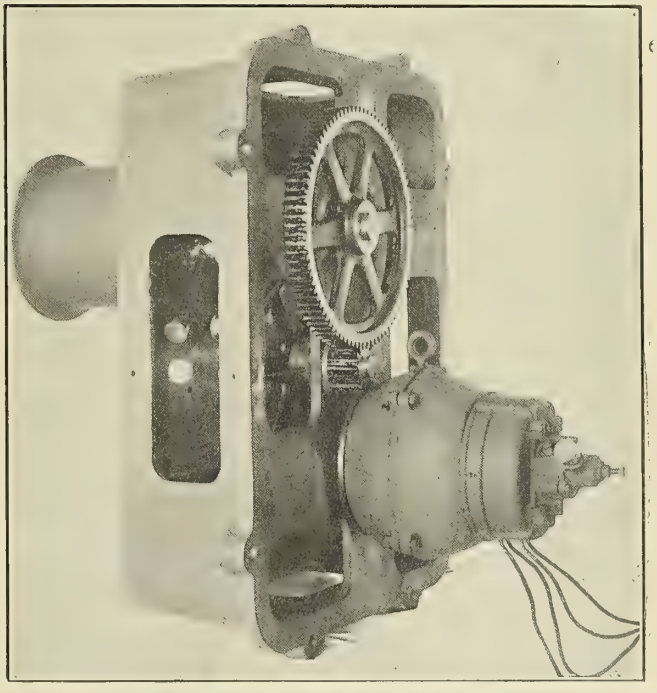


FIG. 4. SPRAGUE ELECTRIC WINCH OR CAPSTAN.

again, when the electric capstan will operate as before, there being no cut-off for him to reset. The whole arrangement is automatic in its operation, and as the cut-off gear is entirely enclosed within the capstan box, it is impossible for a laborer to disturb it or so manipulate it by tying or wedging it as to cause trouble by a desire to prevent it from operating on an overload.

The drawing, Fig. 5, shows another type of English capstan especially designed for wharves and dock yards, and capable of pulling about 2,500 pounds direct from the drum at the rate of 150 feet per minute. This mechanism was designed and constructed by John H. Wilson & Company, Limited, at their works at Sands Hill, Liverpool. It is designed to operate with continuous current or alternating current motors of the three-phase type. The worm and wheel work in an inclosed oil bath, and it will be noted that these machines require but little foundation, being entirely self-contained in a watertight cast-iron box which has merely to be let into the ground and bedded on concrete or other suitable material. For piers and jetties it is bolted to the floor beams. A special feature of these electrically-driven capstans is that they take up very little room between the railway tracks in the yards or on the docks.

It may be of interest to compare these electrically-operated capstans with the steam-driven types. The accompanying illustration, Fig. 6, shows a most compact form of English steam-driven capstan as constructed at Gateshead-on-Tyne by Clark, Chapman

& Company, Limited. To decrease its weight as far as possible the capstan spindle is carried solely by a strong support bolted to the bed plate, the covering over the gearing on the light steam warping capstan being of sheet iron, and made portable with a

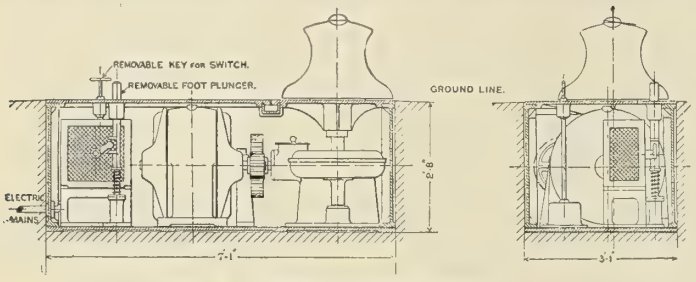


FIG. 5. ENGLISH ELECTRIC CAPSTAN.

hinged door for access to the engine crank shaft. By removing the portable plug in the capstan head the barrel is free to revolve, and can then be worked by capstan bars in the usual way, while a special safety fall is fitted for holding the barrel when working by hand and is so arranged that if properly put out of gear it cannot accidentally engage when the capstan is running by steam. It will be noted that the heavy capstan of the steam-driven type

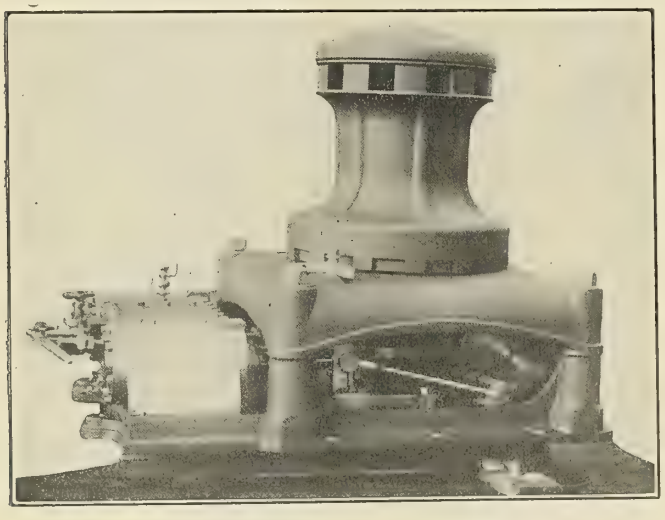


FIG. 6. AN ENGLISH STEAM DRIVEN CAPSTAN.

shown in Fig. 6 is mounted on a heavy cast-iron base with a cast-iron covering for the engine and gearing. Where the capstan is located near a steam-distribution point, as on a vessel or near a boiler plant on a wharf, a steam-driven capstan can be operated to advantage, but it is claimed by eminent engineers that electric capstans are more economical in action than steam capstans where they are located at a considerable distance from the steam generating point; the losses through condensation in the pipes carrying the steam to the engine being many times greater than the losses in the electric conductors carrying current to the motors and electric capstans.

A Dry Dock in Central Africa.

What is probably the highest dock in the world, from the viewpoint of altitude above the sea, has recently been completed at Port Florence, on the Victoria Nyanza, in Uganda, Africa, at an altitude of 3,800 feet above sea level. The dock has been constructed to accommodate the Nyanza fleet plying on the lake in conjunction with the Uganda Railroad. It measures 250 feet in length by 48 feet wide and 14 feet deep. It was excavated out of the solid rock by native labor, and occupied twelve months in construction, at a cost of $20,000. Both the time occupied and the cost of the undertaking were increased owing to plague visitations, which seriously interfered with the work.

MOTOR BOATS, XI.

BY DR. WILLIAM F. DURAND.

Turning now to the chief structural members of the boat, brief memoranda may be noted regarding materials commonly employed, and the characteristics best representative of present practice with regard to such items. We shall first assume the construction to be of wood, as is the more common practice for small boats of the type and character under consideration.

Keel. This is commonly of oak, and for the older form of stern more or less square in section, or with the greater dimension vertical, as indicated in Fig. 50; while for the more modern or torpedo boat stern, the flat keel, as indicated in Fig. 51, is more commonly employed.

The stem and the stern post, where fitted, are also commonly of oak and joined to the keel with oak or hackmatack knees.

Frames. These likewise are commonly of oak, from ½ inch to ¾ or 1 inch square, and spaced 6 inches to 8 or 9 inches between centers, both size and spacing increasing with the general size of the boat, and varying otherwise with the general character of the construction.

Deck Beams. These may be of oak (sometimes of spruce or even pine) and are spaced to suit the frames, and in section may vary with size and general character of construction from ½ to 1 inch in width by 1 to 2 inches in depth.

Deck Planking. This is commonly of pine or cedar, ⅜ to ½ or ¾ inch thick, and often covered with canvas laid in white lead or varnish, as a water-proof covering.

Side Planking. This may be of cedar, pine or mahogany, either single or double, and may vary in total thickness from as little as ¼ inch to 1 inch or more, according to size and character of construction. In ordinary construction, where saving of weight is of no special importance, one layer of ⅞- to 1-inch or even 1⅛-inch stuff represents in general the most serviceable form of planking in proportion to the expense involved. In such form of outer covering special attention must of course be given to the seams with reference to painting and calking, points which will be taken up at a later time. A much more generally satisfactory covering, especially with reference to the ease of keeping water-tight, may be obtained by the use of two layers each ⅜ to ½ inch in thickness, with white lead between and with the joints carefully shifted as between the inner and outer layers. In special construction for high speed boats, cedar or mahogany in layers ¼ or $\frac{5}{16}$ inch thick is employed, and sometimes with a layer of silk or like fabric carrying oil or varnish as a form of stop-water between the layers of wood.

Fastenings. These may be copper rivets and burrs, copper nails clinched or riveted over burrs, screw fastenings of various and special forms, or plain galvanized iron nails and common screws. In all first class work only copper, brass or special bronze is used for fastenings, and wherever practicable they should be "through and through" rather than driven."

Water-tight Bulkheads. In the best modern practice it has become customary to provide for the subdivision of the boat into water-tight compartments by means of bulkheads which must be very carefully designed and fitted, with reference to both strength and water-tightness. From three to five such compartments are considered suitable in cases of typical modern design. The purpose should be to so proportion these compartments that the boat may still float with any one of them open to the sea.

In the ordinary boat with open cockpit there is usually scant room for such compartments at the bow and stern, especially if relatively large seating capacity in the cockpit is desired. If, however, the maximum of seaworthiness and safety is required, the central space must be cut down to such a point that the compartments at bow and stern can be made of size sufficient to give a small reserve of buoyancy, even with the central cockpit

flooded. These are matters which turn chiefly on the question of policy—the extent to which safety is to be sought at the loss of some degree of capacity or convenience in smooth water. The question is one, in any event, which should be carefully considered, and the most recent and representative practice seems to indicate an increasing purpose to combine the highest practicable degree of safety with such other features as the design may contemplate, and to give full value to the importance of water-tight compartments in the consideration of these general questions.

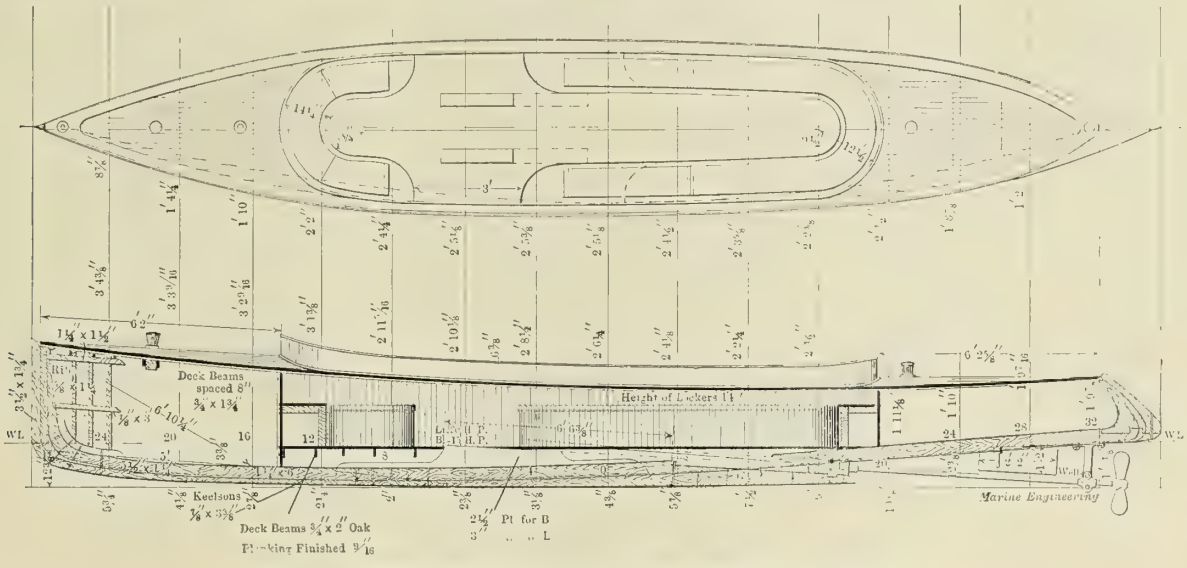


FIG. 54. INBOARD PROFILE AND DECK PLAN OF SPEED LAUNCH EUSONIA.

It should be noted that in many respects there exists the widest range of practice between the construction of an ordinary moderate speed motor boat for runabout purposes and the special high speed racing machines, where the conditions for high speed are carried to the farthest possible extent, and involving most careful study of structural features in order to realize the maximum of strength and stiffness on the minimum of structural weight. Certain special features of construction found in boats of this type may be summarized as follows:

(1) Depending on the size of the boat, the frames are reduced in section and made of carefully selected material with a somewhat reduced spacing to offset, at least in part, the decrease in local strength caused by the reduction in thickness of side planking. With proper care in design the general balance between increase in number of frames and decrease in sectional area may be made to yield an important saving of weight as compared with the more ordinary schedule of construction.

(2) The side planking is commonly in two layers each $\frac{1}{16}$ to $\frac{5}{16}$ inch thick. In certain cases, however, a single layer of such covering is used, the seams being covered on the inside with strips worked as stringers, thus avoiding the need of calking, and effecting a saving in weight as compared with the more common double plank covering.

(3) Special diagonal bracing on the inside of the frames may be worked, adding strength against torsional stress, and aiding in the general consolidation of the framework together into an engineering structure.

(4) In certain cases special girder-like structures with top and bottom chords, timber struts for compression and steel wire for tension, have been worked along the sides of the boat inside, to aid in giving the necessary longitudinal strength against sagging and hogging stresses.

(5) Special forms of framing have been employed, as in the case of the *Standard,* and as a result of which marked saving of weight has been effected. The following brief description will give the principal features of the special framing employed in this case:*

The length over all is 60 feet and on the water line 58 feet, with an extreme beam of 7 feet 6 inches. The planking is of single thickness Honduras mahogany $\frac{3}{16}$ inch thick, and with edges secured by flush screws to continuous longitudinals of Oregon pine, after the manner noted in (2) above. The framing is carried out on a special double system consisting of inner and outer frames and longitudinals. The longitudinals are notched over the outer frames, and all three parts of the structure are through riveted, giving great transverse strength on a minimum of weight. The inner frame is furthermore carried continuous up the side and across, forming the lower member of the deck beam, while the upper member of the same runs across from side to side and ends at the plank-sheer. The longitudinal strength of the boat is obtained chiefly from two truss girders running from end to end in the wings, and consisting of upper and lower continuous longitudinals, wooden compression struts and galvanized wire diagonals set up tight, substantially as noted in (4) above.

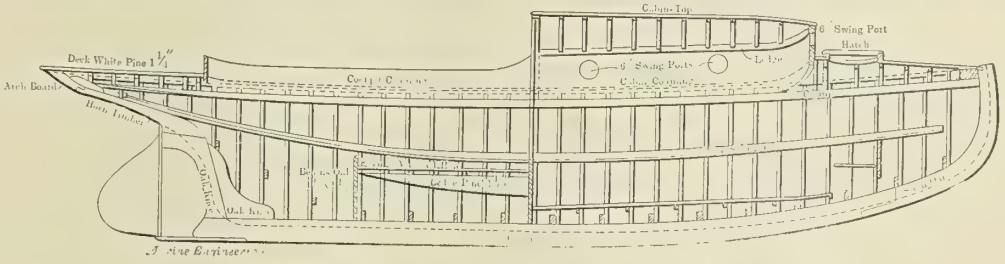


FIG. 55. LONGITUDINAL SECTION OF SMALL MOTOR BOAT, SHOWING FRAMING.

(6) Local stiffening is reduced to a considerable extent by accepting a narrower margin of safety in this direction, and by a

*See Marine Engineering, March, 1904, page 127.

careful study of the disposition of the material in such manner as to realize maximum strength for minimum weight.

As a result of special construction along these lines, results have been realized giving a weight of hull of about one-third the total ultimate displacement as compared with one-half to two-thirds for more ordinary modes of construction.

The use of structural steel for motor boats may be passed over with but brief reference. While there are not a few boats of the general motor boat type, especially in the larger sizes, which are built of structural steel, yet it must be admitted that the typical mode of construction of such boats is of wood. In cases of steel construction, furthermore, the general characteristics are similar to those met with in larger craft, or in wooden construction as well. The framing is made up of deck beams, transverse angle iron frames, longitudinal keel plate and stringer angles, with plating disposed in much the same manner as for larger craft, and fulfilling the same general functions.

Having in view the foregoing brief discription of the principles involved in practical boat construction, it will be of interest to give in some detail the following description* of the scantlings and structural features of a typical modern high speed motor boat, in which several special structural features have been introduced, and which yet represents excellent practice with respect to the main lines of small boat design and construction. See also Figs. 52 and 53 for section of this boat.

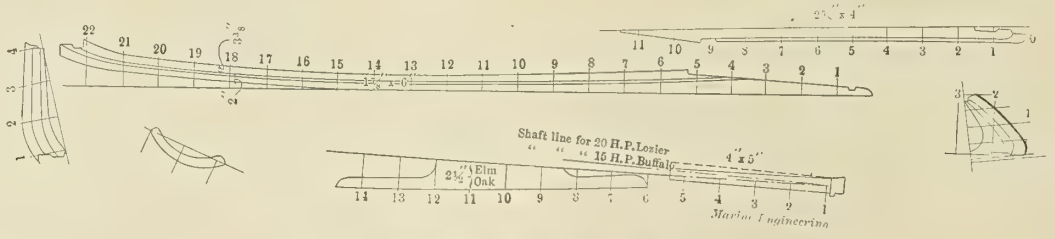


FIG. 56. DETAILS OF KEEL, STEM AND STERN, OF EUSONIA.

PRINCIPAL DIMENSIONS.

Length over all	56 feet	8 inches
Length on deck	55 feet	8 inches
Length on water line	54 feet	4 inches
Extreme beam	7 feet	
Draft	3 feet	

The boat is constructed almost entirely of wood, with fastenings of copper and Tobin bronze. At a few points castings have been used of gunmetal or manganese bronze.

The keel is of white oak made in two lengths, having a width of 4 inches at the forward end and increasing to 10 inches amidships, at which width it is continued to the stern post. The scarf between the two sections of keel has a length of 24 inches, and is fastened with five ¼-inch copper rivets and two brass screws. The keel is rabbeted to receive the side planking. The stem is of chestnut, secured to forward end of keel by means of a 32-inch scarf. The stern post is of white oak 4 inches deep, and secured to the after end of the keel and to quarter timbers by means of a hackmatack knee.

The frames are of selected white oak, extending in one length from the plank sheer to keel, from the stem to frame number 60 inclusive. In the way of quarter timbers the frames are in two lengths, connected by a hackmatack knee. From frame number 60 to quarter timbers the frames overlap the keel or center line, reaching a maximum of 16½ inches at frame number 40. All frames are spaced 8 inches between centers, and measure ⅞ by ⅞ inch at keel and ⅞ by ¾ inch at head. The frames between numbers 32 and 53 extend up above the plank sheer to form coaming and sides of turtleback.

*See Marine Engineering, September, 1905, page 372.

The floors forward of frame number 59 are of white oak measuring 1¼ by 1½ inches. Side keelsons of Oregon pine are fitted measuring 2½ inches on the siding from frame 15 to frame 59 inclusive, and diminishing to 1½ inches at the ends. The top strake measures 2½ inches for three-fifths length amidships, and 1½ inches at ends, while the figures for the bottom strake are 1½ inches and 1 inch respectively. These keelsons are connected by hackmatack floors with cedar braces and stiffeners, and also by occasional 2- by 2-inch spruce struts. Engine keelsons measuring 2½ by 3½ inches extend from frame 38 to frame 53, and carry the weight of the machinery.

The deck beams are of white oak 1¾ inches by 1 inch, except that beams at frames numbers 1 and 4 are 1¾ by 1¾ inches, and at numbers 6 and 32, 1¾ by 2½ inches, the latter dimension in each case being the siding or width. All beams are spaced one on each frame and crowned 2 inches amidships, except as modified by the turtleback structure.

The sheer strake is of white oak ⅞ inch in thickness and about 4½ inches wide, the lower edge being rabbeted to receive the double planking. It is worked with a molding 1 3/16 inches in thickness as shown on sections. The bilge stringers are of clear Oregon pine in one length, 2 by 2 inches for three-fifths length amidships, tapering to 1½ by 1½ inches at the ends. The planking is in two thicknesses, with a width of 4 inches on the sides, increasing to 5 inches on the bottom. The inside thickness is of cedar, 5/16 inch thick, and the outside of mahogany, ⅜ inch thick. These are separated by Union silk covered with varnish, and are held together with button-headed brass screws.

The plank sheer is of mahogany, ⅝ inch thick on outside and ½ inch on inside and 4½ inches wide, fastened to each beam and to edges of sheer strakes with brass screws. The deck plank is of white pine ½ by 2½ inches at the stern and amidships, and ⅜ by 2 inches on turtleback, the seam being laid in white lead.

There are three bulkheads, located respectively on frames 6, 32 and 59. All are constructed of white cedar in two diagonal layers each ¼ inch in thickness, with a layer of Union silk between, covered with varnish, and all fastened together with copper rivets.

Announcement is made of the sale by the Moran Brothers Company of their shipyard in Seattle, Wash., to eastern capitalists, who will continue the operation of the plant on the lines already laid down, and which have proved so successful. It is understood that the sale price is in the neighborhood of three million dollars. The withdrawal of the Moran brothers from active control of the great enterprise which they founded twenty-four years ago is due to failing health. It is understood that the battleship *Nebraska*, which has been building in the yard since 1902, will be completed by the original firm.

The new organization, which will be known as the Moran Company, will be under the general management of George H. Higbee, while the works will be in charge of J. V. Patterson, lately naval architect at New York for the American Line.

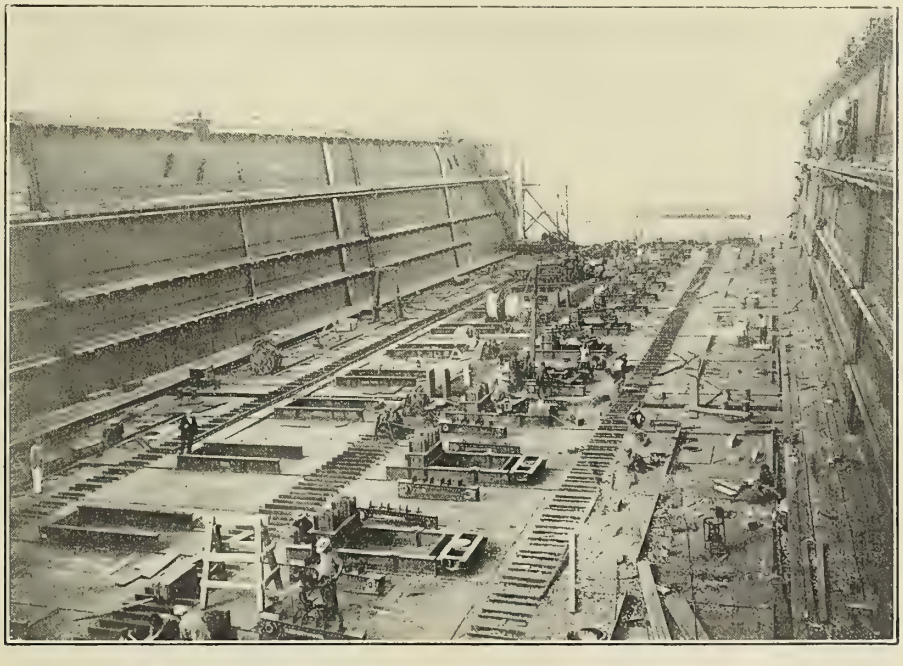
The new capital is $2,000,000, of which one-half is common and one-half 7 percent cumulative preferred. There are 10,000 shares of each.

AN INTERESTING IRON FLOATING DOCK.

There recently left the stocks at Tsingtau, China, an iron coffer or floating dock capable of lifting the biggest battleship in the world, its bearing capacity being no less than 16,000 tons. Due to the enormous dimensions of the dock in question, necessitated by its high bearing capacity, it ranks as one of the largest of its kind in the world. This dock, which has taken two years to construct, was built for the German government by the "Gutehoffnungshütte," of Oberhausen. The total weight of the construction is 8,800 tons. The dock was launched complete, ready for operation.

SIDE LAUNCHING OF IRON FLOATING DRY DOCK AT TSINGTAU.

The dock consists of five detachable bottom pontoons with superimposed lateral chambers or boxes by means of which the pontoons can be rigidly attached to each other. The entire dock has a length of 410 feet with a width of 128 feet. The height of the pontoon on the centre is 19 feet, while the lateral boxes or sidewalls are 43 feet high, so that the total height of the dock amounts to 62 feet, in round figures. Each pontoon has a length of 80 feet, and is divided into eight watertight cells by means of three longitudinal bulkheads and one main framing. The water ballast is pumped out of these cells by means of ten horizontal centrifugal pumps, two of which are located in each pontoon; they are actuated by electric-motors coupled direct to the pump rods. The starting and stopping of these motors, and the control of the slide valves required for the pumping plant, is effected by the aid of electricity from a controlling station located upon the lateral boxes. The electric current is supplied from a central station situated on the land. By means of all these devices the dock, with the vessel lying therein, can be raised within a period of two hours. In addition to the three bulkheads mentioned above each pontoon has 28 transverse framings which serve as stays. The lateral boxes or chambers are also strengthened by bulkheads and frames, which are located directly above the transverse stays of the pontoon. E. O.



DECK VIEW OF THE NEW DOCK, BUILT FOR THE GERMAN GOVERNMENT.

THE MOLDING OF PROPELLERS.

BY W. F. D.

For the operation of molding and casting the screw propeller, two general methods are available, involving respectively the use of the pattern and that of the sweep. A fully detailed description of these methods would far exceed the limits of these columns, and we can therefore give only an outline of the process in either case.

For quite small propellers complete patterns are commonly employed, and insure the maximum rapidity of production. For larger propellers a hub and pattern for one blade is more commonly used, the single blade pattern being molded in as many positions as may be necessary to provide the number of blades desired. For a propeller with separable blades, a hub and single blade pattern are always employed, the blade pattern being remolded as many times as may be necessary to give the requisite number of blades. For large propellers which are not likely to be duplicated often, and for which therefore the expense for patterns could be less properly undertaken, the method of sweeping up the mold is commonly employed. The choice between the method by pattern and the method by mold is chiefly a question of the number of duplicates likely to be required. Where several propellers of the same dimensions and form are to be built, it will be advantageous to have a pattern; where only one

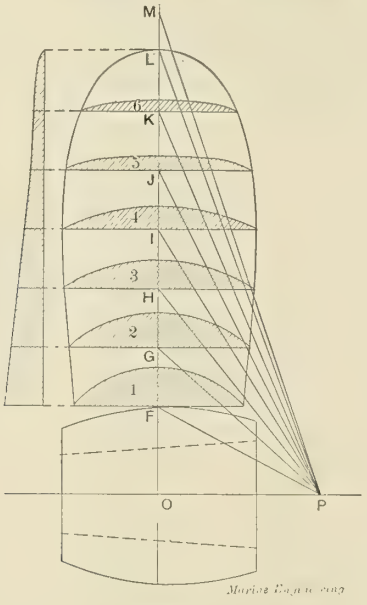


FIGURE 1.

is required, with uncertainty as to duplication, the expense of the pattern may be in large measure avoided by the use of a swept mold.

THE USE OF PATTERNS.

The construction of a screw propeller pattern implies, of course, the making in wood of an exact full sized model of the propeller, or at least of the hub and one blade. To this end the propeller drawing must furnish the following information:

(1) The general dimensions of the propeller, or more particularly *diameter* and *pitch*.
(2) The form and dimensions of the hub.
(3) The form of the developed surface of the blade.
(4) The form and inclination for each of a series of "guide iron" edges across the blade, at a series of radial distances from the hub to the tip of the blade.
(5) The lay out of thickness along a midrib from hub to tip of blade, and transversely of the blade from entering to following edge.

Such information for a uniform pitch propeller with straight radial blades is indicated in Fig. 1, and includes everything needful, no matter which method of molding the propeller be followed. It will be unnecessary to discuss in detail the pattern for the hub. An outline of the process for constructing the pattern for the blade may be indicated by the following steps:

(1) Form the pattern for the hub first as a cylinder—that is, with equal diameter throughout its length and equal to the maximum finished diameter $O F$, Fig. 1.

(2) Prepare a "surface board" or platform, smooth and level and large enough to lay out and support the pattern for the hub and one blade.

(3) Out of thin sheet metal cut a triangle similar to $P O F$, Fig. 1, and bend the same so that the side similar to $O F$ is brought to the arc of a circle of radius equal to $O F$.

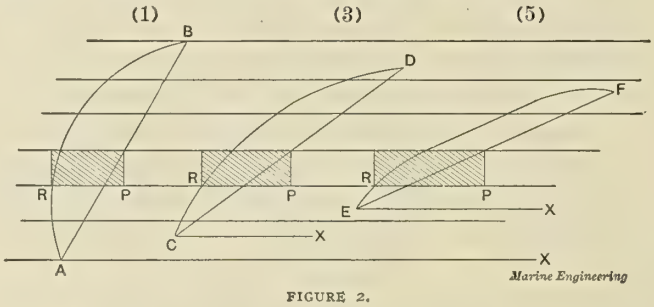


FIGURE 2.

(4) Lay this on the hub with side similar to $O P$ parallel to the axis of the hub, in which position the line similar to $P F$ will give the intersection of the blade surface with the hub.

(5) Cut a deep V-groove in the hub with one edge brought to the line determined by the hypotenuse of the curved guide as noted in (4), taking care to have the width of the groove on the side corresponding to the thickness or back of the blade, and also to cut the groove of sufficient depth near the ends of the hub to allow for such tapering off as the finished form of the hub may require.

(6) Lay out full size, and each at its own inclination, a series of blade sections, of which numbers 1, 3 and 5 of Fig. 1 are shown in Fig. 2. In each case the inclination of the lines $A B$, $C D$, etc., with the horizontal equals the inclination of the corresponding lines $P F$, $P H$, $P J$, etc., with the transverse or $O X$. Thus angle $B A X$ = angle $P F O$, $D C X = P H O$, and similarly for the entire series of sections of Fig. 1.

(7) On these inclined sections lay off a series of slices or "lifts" as shown, and representing the layers out of which the blade pattern is to be built up.

(8) Select a piece of stuff of the proper thickness for one of the lifts, and of sufficient width to give the widest of the dimensions similar to $P R$ as shown on the series of inclined sections, and for, say, lift number three from the bottom. At points F, G, H, etc., Fig. 3, representing the points similarly lettered in Fig. 1, lay off widths F 1, G 2, etc., equal respectively to the successive dimensions $P R$ of Fig. 2. Then spring a batten through the points 1, 2, 3, etc., and cut the piece with a square edge down to the line thus determined. This operation will give the form of lift number 3 for the blade pattern. Near the edges of the blade, where the contour may fall short of filling out the entire thickness of the lifts, as indicated in Fig. 2, the lift should nevertheless be continued the full length, and of sufficient width to insure a good joint with the one adjacent. When a lift runs out of the contour entirely, as near the tip for the top and bottom lifts, it may be continued of uniform width equal to that for the section nearest the point where it leaves the contour of the blade. Suitable dispositions regarding these various details will readily present themselves when dealing with the actual problem.

(9) In this general manner, therefore, the entire series of lifts is laid out and brought to form. In all such operations care should be taken to number and mark each lift so that it may be readily identified and located in place in the operation of assembling.

(10) The inner ends of the lifts, which should be left long enough for the purpose, are then beveled down so as to fit in the

V-groove in the hub, and number *1* (or that for the bottom of the blade pattern and corresponding to the after or following edge) is fitted in place in the hub and secured with dowels and glue. In fitting this in the hub the edge on the face side should be beveled off so that it will lie just in contact with the line of the guide, as determined in (4).

(11) A guide similar to the triangle *P K O*, for example, and corresponding to the radius *O K*, is next made and bent so that the side similar to *O K* is brought to the arc of a circle whose radius is *O K*. This guide is then set up with side similar to *O P* parallel to the hub axis, and on the circle of radius *O K*, and whose curvature it is bent to fit. Furthermore, these two

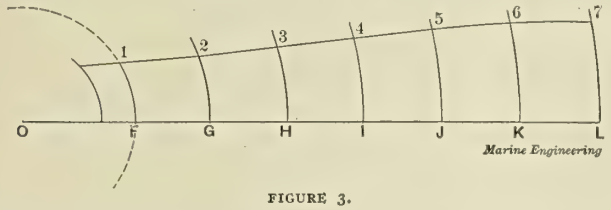


FIGURE 3.

guides should be so located that a radius of the propeller, as *O R*, Fig. 8, drawn from say the mid height of the inner hub guide, will just rest on the outer guide, also at its mid height.

(12) Where the lift would then come in contact with the outer guide at radius *O K*, Fig. 1, it should be beveled on the straight or blade face edge until it is brought to the angle determined by the guide, and with the upper angle of the straight edge just resting on the guide.

(13) In similar manner the successive lifts should be fitted and secured in place in the hub, and to each other likewise, by glue and nailing, care being taken with the latter to avoid locating nails where they may interfere with the later work of reducing to finished form. There will thus result a step-formed block of which a beveled line at the hub will lie along the line of intersection of blade surface and hub, while a similar line near the tip will lie on the guide corresponding to radius *O K*, and will therefore give the finished surface on a line across the blade at this radius.

(14) It follows that the lines determined by the inner angles of the steps on the straight side will all lie on the final helicoidal surface of the blade, and it therefore remains only to remove the projecting angles and bring the entire driving face just down to the lines determined by these inner angles. The fact that the lines determined by these angles lie on a helicoidal surface results from the definition of such a surface, and must be accepted here without further mathematical proof.

(15) The developed contour of the blade as given in Fig. 1 is then laid off on the blade surface, reckoning from the center

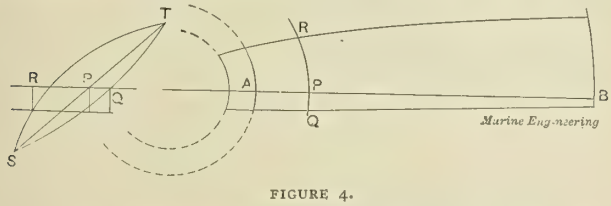


FIGURE 4.

line *O L* laid off on the pattern from hub to tip. The part outside this contour being then removed, the final contour of the blade remains.

(16) It is readily seen from the manner in which the widths of the lifts have been determined, that the form of the back of the blade will also be determined by removing the outer angles of the lifts on the curved or back edge, and reducing the surface just down to the lines determined by the inner angles on the back or thickness side of the pattern. These indications will not be definite near the boundary of the blade, and for the finished angle at the edge of the blade it is best to have a separate gauge made by setting an ordinary bevel gauge at the general edge angle for the outer or thinner parts of the blade and supplemented by other special gauges for the angles at the thicker parts of the blade. These various angles may be taken from the drawings, and for the thin part of the blade may vary from 8 or 10 degrees for bronze to 20 or 30 degrees for cast iron.

With such gauges for the edge and the guide given by the inner angles of the step-wise pattern, the form of the back may be very satisfactorily worked out. After determination in this general manner the thickness layout may then be tested by calipering and comparing with the drawing board layout as given by the sections of Fig. 1.

(17) The hub may next be worked down on front and rear ends and given such form of taper or curve as the design may call for.

The angles where the blade and hub are joined must be well filleted. This may be effected by cutting and putting in the fillets after the surfaces of the blade are brought to form. If desired, however, the fillet for the back may be readily formed in place from stock provided for that purpose, but for the face side it will be better to cut and fit the fillet separately.

(18) The final details of smoothing and finishing the pattern for use in the foundry may then be carried out in the usual manner for operations of this character.

Should it be desired to place a part of the thickness on both sides of the fundamental geometrical surface, as is sometimes the case, the blade pattern lifts must be modified accordingly.

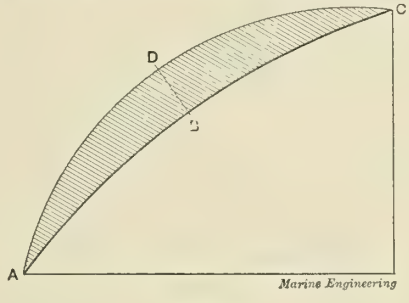


FIGURE 5.

The blade sections will give the layout desired as indicated by the section of Fig. 4. The point *P* would lie on the ideal geometrical surface, of which the line *S T* denotes the developed guide for the location of this particular section. A line *A B* on the blade lift is then drawn to denote the radial line which is supposed to be seen end on at *P*. The distance *P R* is then laid off on one side of *A B* and *P Q* on the other, and similarly for all the other inclined sections, thus giving a thickness distribution on both sides of the line *A B*. It is seen that this is equivalent to starting with an ideal surface determined, as above described, by *A B* and other straight lines similar thereto, and then laying out in the manner described in (8) to (16) above, a certain distribution of thickness on each side of such foundation surface. With these general hints no trouble should be experienced in laying out any distribution of thickness which may be desired.

In case the blades are to tip or rake back instead of standing at right angles with the shaft, it will be necessary to correspondingly tip or incline the lifts of the blade pattern down from the hub outward, for a pattern made face down. In such case the same general methods are to be followed as already described, with the substitution of the inclined angle for the blade lifts. With due attention to the principles involved in the operations above described, no difficulty will be found in thus adapting them to the case of a pattern for blades inclined back from the perpendicular.

Should it be desired to make a pattern for the propeller complete, so that it may be molded entire in one operation, it is only necessary to repeat for each blade the same general process outlined above, locating the blade patterns, three or four in number, at the proper points about the circumference.

If the propeller is to be made with separable blades, then the hub and blade patterns are made and cast separately. Details for the hub pattern will be given by the drawing, and its construction will present no special difficulties. The blade pattern may be made in the same general manner as above described, except that at the inner end it is attached to a boss or flange instead of a hub. The pattern for the boss, which is usually spherical on the outer surface, may be made separately and then set up in position on the surface board. The guides corresponding to hub and tip as previously described may then be prepared and set up in similar manner, the inner one just touching the boss pattern at the extremity of its spherical form. A light straight rod may then be placed on both guides, levelled up and moved up and down the guides, being kept horizontal or levelled up in the meantime. The inner end of this rod being carried into contact with the boss will then trace thereon a line which will give the intersection of the blade surface with the boss, and which will serve as a guide for the groove into which the lifts of the blade pattern are to be secured.

If it be desired to form the boss of the same pieces as the blade pattern, then sufficient stock must be left on the lifts as shown by the sections of the boss, and the lifts are then to be simply lined up and adjusted with reference to the two guides set up as before. The lifts being then glued and nailed together, the boss may be formed up in accordance with the dimensions shown by the drawing, and for which provision has been made in the extra stock left on the inner ends of the lifts.

In small propeller patterns it may be desired to form the hub together with the blade. In such case it is only necessary to saw out circular sections of the hub with each lift, and to mount them as above described, the collection of hub sections thus forming the hub pattern as a whole.

In case the propeller is not of uniform pitch from leading to following edge, the developed guides will have the hypotenuse, *P F* or *P K*, Fig. 1, curved instead of straight. In such propellers the pitch usually increases from leading to following edge, thus rendering the face of the blade hollowing or concave and the corresponding guide convex as indicated in Fig. 5.

When the propeller is to have different values of the pitch from hub to tip, and especially if the distribution of pitch is generally irregular, it may be preferred to modify the general procedure outlined above, and to determine the driving surface of the blade by means of a number of guides each giving the slope suitable for its location on the blade, and without reference to radial lines determined by the inner angles of the blade pattern lifts as before.

To this end the process may be carried out as follows:

(1) A series of lifts is prepared, of sufficient width to insure stock for blade thickness, but without attempt to lay out such width from the sections as before.

(2) These lifts are then glued and nailed up in general slope to correspond with the mean or average value of the pitch, but without any attempt in this part of the process to fit them accurately to any of the guides.

(3) Prepare the hub pattern and hub guide and lay out and cut groove as in (3), (4) and (5) of the preceding method. Then trim inner end of blade pattern to fit groove, and secure in place as previously described.

(4) A series of guides is then prepared, corresponding to successive locations from hub to tip, and each one having the form suitable for the distribution of pitch at that particular distance from the center of the hub.

(5) Marks must then be established so that when these guides are lined up along some reference line on the surface board, the various guide lines similar to *P F, P G, P H,* etc., Fig. 1, will all correspond in height, and will therefore lie on the surface of the blade as designed.

(6) One of the guides is then located on the circle and adjusted to its reference mark, and the blade and hub are swung on the center or propeller axis until the blade pattern comes in contact with the guide. Inspection of the two will show how the blade is to be pared down in a line across the block in order to bring it into contact with the guide. This process of paring and fitting must then be carried on until the block is brought to a satisfactory fit with the guide, while at the same time the block as a whole is brought around to some definite and selected position on the board indicated by witness marks on block and board, such position being chosen by judgment in such manner as to insure sufficient stock at all parts of the blade for bringing the pattern down to a fit with the corresponding guide. The next guide is then set up in its place and adjusted to its reference mark and the block brought around and pared across until ultimately when brought to the blade witness mark it will show full contact with its guide across this part of the blade. The remaining guides are set up and the operation is carried through in the same manner for each, at the end of which series of operations there will result a series of grooves across the blade, the bottoms of which will in each case lie in the surface of the blade as designed. It only remains therefore to take down the intermediate high parts and gradually bring the face to a smooth and continuous surface, just containing the bottoms of the grooves as determined from the guides, and which may be conveniently marked by colored crayon in order that they may be more easily identified when bringing the surface down to its final form.

(7) The back is then smoothed off likewise in bands across the blade, and is given a thickness layout as determined by caliper and corresponding to the sections given by the drawing, as in Fig. 1.

Some pattern makers would prefer to follow this latter general plan in making all patterns, whether for variable or uniform pitch. In the latter case the developed guides are all triangles with straight line hypotenuse as in Fig. 1, and each is bent up and located as described. The general process thus amounts to a determination of the finished surface by means of a series of lines across the blade, each brought down to fit a corresponding guide, and the high parts being then removed to form a smooth and continuous surface; while in the other case the form is determined by means of a series of straight radial lines resting on two guides, as above, the high parts or angles being then removed to form a smooth and continuous surface as before. Both methods are geometrically correct and with proper care both will give the same final result for a given pattern. As a rule, however, the first method may be recommended for propellers of uniform pitch, or where the pitch does not vary radially, while the latter method will be found more practicable for radially varying or other complicated distributions of the pitch.

The pattern indicated in the sketches is laid out face down. This again is a matter of choice, and some pattern makers prefer to make it face up, especially when following the second general method as above described. The differences in the two methods are found however only in the details, and with a good understanding of the principles involved, no trouble should be met with in carrying out the process with the pattern either side up on the surface board.

SWEPT UP MOLDS.

Turning now to the swept up mold, the principal steps in the process may be indicated as follows:

(1) Prepare a smooth level foundation of sufficient size to accommodate the entire propeller, and with some 6 to 10 inches extra outside the tips of the blades.

(2) In the center of this floor set up a vertical iron post—usually a piece of shafting—and secure the same at the top to give perfect steadiness to the sweep arm which it is to carry.

(3) Make sweeps for the hub and for the foundation as indicated in Fig. 6. Then sweep up the hub in the usual manner over a brick work core, and level up the foundation with the sweep prepared for that purpose. The outer end of the sweep at *A* will produce a bed for the guide, and the central part at *B* a slightly raised bed for the hub. In some cases the hub pattern is made in wood and set in place, instead of sweeping it up out of loam.

(4) Prepare the blade sweep, the entire arrangement being assembled and adjusted somewhat as in Fig. 7. The edge of the board should be brought down nearly sharp at one angle as at *a*, and if desired may be shod with metal to insure against wear. The length *C D* should be sufficient to bring the point *D* some 6 or 8 inches beyond the tip of the blade.

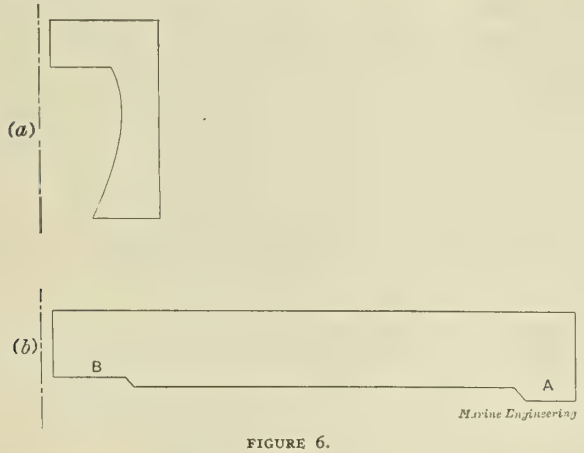


FIGURE 6.

(5) Prepare a "guide iron" similar in form to those described in connection with the construction of a pattern in wood, but corresponding to a radial distance about 6 inches beyond the tips of the blades, in order to allow for the joint of the mold, and as represented in Fig. 1 by the triangle *P O L*. This "guide iron," so called, may be made either of sheet metal—thin boiler or ship plate usually—or of wood and shod with metal on the upper or guide edge. The construction in wood may be carried out as follows:

In Fig. 8 (a), let the curved contour denote the form of the blade projected on a transverse plane, or as seen from aft looking forward. Draw two radial lines as shown, thus comprising between them the entire face of the blade. Continue these to a distance of about 6 inches beyond the tip of the blade, and draw the arc *P Q*. Then prepare a block of wood of length *A B* and breadth *B C* as shown, and of height slightly greater than the greatest projected longitudinal dimension of the blade *R S* (b). Lay out on this block the curved strip *P Q* as shown in Fig. 9, and of mean radius the same as that of *P Q*, Fig. 8, and cut it out with band saw, thus giving a sector of a cylindrical shell of one to two inches thickness. Then cut out of sheet iron or heavy paper a triangle similar to *O P L*, Fig. 1, and of dimension *O L* not less than *P Q*, and fold it about the shell *P Q*, the side

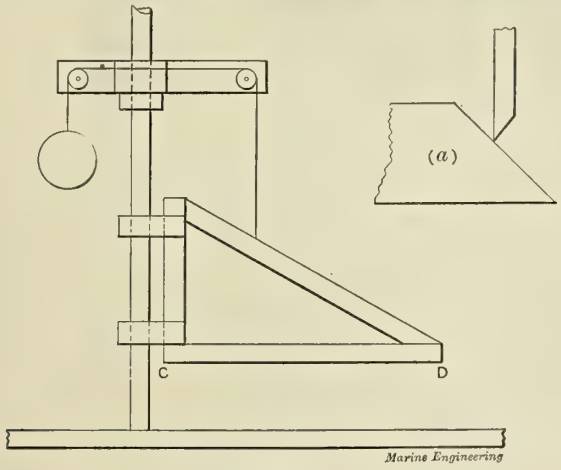


FIGURE 7.

O L along the base and *O P* vertically. Mark on the convex side of *P Q* the line along the hypotenuse *P L* and cut the shell down to this line, and the guide is ready for use. If desired it may be protected with sheet metal on the inclined or guide edge.

(6) Set up the guide on the foundation at the proper radius and between iron pegs driven into the sand to hold it in position. Care must be taken to adjust the height of the guide to correspond with that of the hub. If then the sweep edge is brought down into contact with the guide and the sweep is so moved as to keep the edge constantly in contact with the guide, the edge will describe the exact helicoidal surface which it is desired to give to the blade.

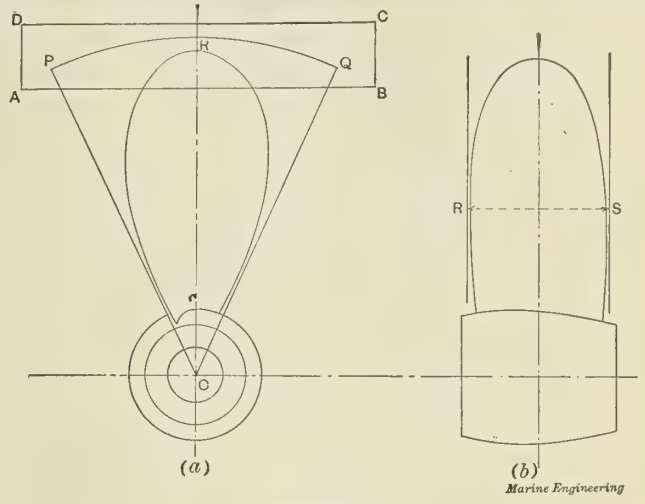


FIGURE 8.

(7) Prepare a sloping foundation of brick-work between the hub and guide and of the general slope which the blade surface will show, keeping the same a few inches below the finished surface as indicated by the location of the sweep edge *C D*, Fig. 7, when moved up and down in contact with the guide.

(8) Spread loam on this blade foundation and then follow up and down with the sweep, smoothing off and packing up until a smooth continuous surface of loam is thus developed. This represents the face side or surface of the blade.

(9) Lay out on this surface the blade center line, corresponding to *O L*, Fig. 1, and from this line lay out the blade contour full size on the loam from the dimensions taken from the drawing.

(10) Brad points inserted in the sweep edge at points corresponding to the location of the blade sections of Fig. 1 will trace in the loam surface lines showing the location of the full sized blade thickness strips. These are to be sawn out of about ⅞ inch stock, and in form as given by the blade sections of Fig. 1, and then saw-kerfed in lines perpendicular to the blade surface, so that they may be bent to follow the lines drawn in the loam by the brad points. These thickness strips may then be secured in place each on its own line by brads or thin nails pushed into the loam.

(11) The loam surface is then treated with parting sand and the spaces between the thickness strip filled in with molding

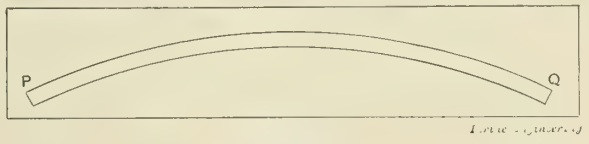


FIGURE 9.

sand and smoothed off on top to a continuous surface, thus forming the rounded back of the blade.

(12) This is next treated with parting sand and the cope of the mold is put in place, filled, and rammed up in the usual manner. Great care must be taken in ramming not to disturb or injure the blade pattern in sand.

(13) These same general operations are repeated for each blade of the propeller, three or four in number about the circumference, and also for the hub.

(14) The blade copes are then lifted off, carrying each one the reverse form of the back of a blade. The blade patterns in

sand are then removed and destroyed, leaving the original helicoidal surface as generated by the sweep.

(15) The hub is next removed similarly, and the copes are

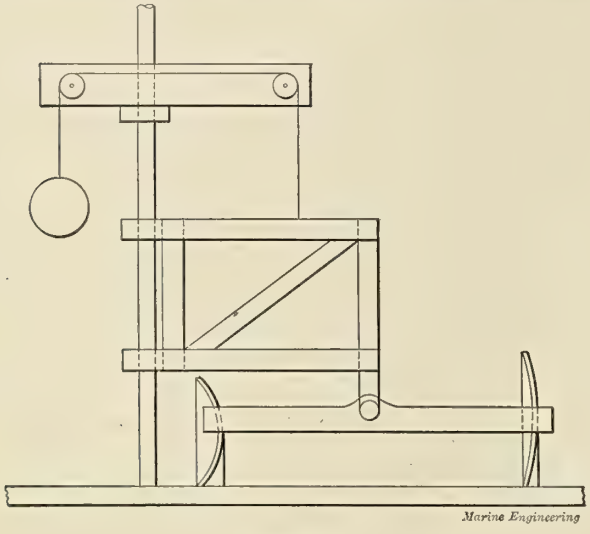


FIGURE 10.

then returned in place; and with the upper and lower parts of the mold together the form of the propeller complete is left as a cavity to be filled with the molten metal.

Many minor steps are omitted in the above brief description, but with a general knowledge of foundry methods and principles, and a careful study of the operations noted above, no serious trouble should be met with in sweeping up the mold for a propeller of uniform pitch and with blades perpendicular to the axis.

If the propeller is of moderate size a single cope may be employed for the entire propeller instead of one for each blade and the hub. Where adequate provision is at hand for lifting and handling heavy copes, such method would usually be preferred in any case.

If the blades are to be tipped back from the perpendicular the sweep edge must be correspondingly tipped down from the post outward. Otherwise the general operations are the same as for straight perpendicular blades.

In case the pitch is expanding—that is, increasing from entering to following edge—the developed form of the guide hypotenuse will be rounded or convex instead of straight. Otherwise the operations are the same as above.

When the pitch is to vary radially two guides must be employed, one at the hub and the other at or beyond the tip, while the sweep must be pivoted on an arm carried as indicated in Fig. 10.

In case the thickness is not all placed on the back of the blade or on one side of the geometrical surface developed by the sweep as above, then the guides must be modified accordingly and as determined by trial, until the desired distribution of thickness is obtained. Such a distribution of thickness, partly on the driving face, results really in a modification of the face pitch; substituting for a uniform or simple variation, a complex and possibly extreme variation, as determined by the actual resulting surface of the driving face.

A NOTABLE ELLERMAN LINER.

BY BENJAMIN TAYLOR.

One of the most striking developments in the British shipping industry of recent years has been the combination now known as The Ellerman Lines, Limited. Originated by Mr. J. R. Ellerman, Liverpool, it owns now not only the "Ellerman" steamers whose names all terminate with "ian," but it has acquired the "Hall" Line of Liverpool, and the historic "City" Line of Messrs. George Smith and Sons, Glasgow. This progressive concern now owns no less than 80 steamers, aggregating 175,000 tons, and in order to open up new services and increase old ones it has at present some 37,000 tons of new tonnage under construction.

THE NEW ELLERMAN LINE STEAMER TRAFFORD HALL.

One of the latest additions to this fleet is the steamer of which we present photographs, the *Trafford Hall,* which was built by Messrs. Barclay, Curle and Company (Limited), Glasgow, and which has just taken her place on the Indian service of the lines. The expansion in trade between Great Britain and India has rendered it necessary to make a considerable addition to the fleet. The same builders have still three vessels of a similar type in hand for the owners. During the past fifty-seven years these builders have constructed for the Ellermans thirty-five vessels, with a total tonnage of 68,141 tons.

In some respects the *Trafford Hall* is unique. She is the largest steamer of the Ellerman fleet, and she has the largest passenger accommodation of any vessel trading between Glasgow and Liverpool and Indian ports. She was built to the classification of the British Corporation Registry.

The *Trafford Hall* was designed for a sea speed of 11½ knots, but on trial runs a mean speed of fourteen knots was maintained.

VIEW LOOKING FORWARD FROM NAVIGATING BRIDGE.

She was specially designed for a new monthly express passenger service from Liverpool to Egypt, Bombay and Karachi. The average passage to Port Said is to be in ten and a half days, and to Bombay in twenty-one days, canal excluded. Accommodation is provided for 100 first class passengers.

The dimensions are:

Length over all	410 feet
Breadth	50 feet
Depth from top of upper deck at centre	32 feet 7 inches
Gross registered tonnage about	5,500 tons

THE TRAFFORD HALL, LOOKING AFT FROM STARBOARD BOW.

The steel hull is divided into watertight compartments and a complete inner bottom is fitted fore and aft, which, besides insuring safety in the event of grounding, allows the trim and draft to be adjusted to suit different conditions of service. Poop, bridge and forecastle are built on the upper deck; the bridge forms the lower promenade for first class passengers, and above this are the upper promenade deck, lower and upper navigating bridge decks.

clusters for use when discharging cargo at night. Awnings are fitted fore and aft and six lifeboats placed where they can be rapidly put into the water when required.

The machinery consists of triple expansion engines supplied with steam from three large boilers, with a working pressure of 215 pounds. The boilers are fitted with Howden's forced draught and with superheater. The outfit of auxiliary machinery includes large condensers for renewing the supply of fresh water.

FIRST CABIN DINING SALOON ON NEW ELLERMAN LINER.

The passengers are berthed amidships and the sleeping cabins are on the upper bridge and promenade decks. These cabins are large and well ventilated, and several of them are convertible into double rooms. A nursery is provided for children.

The dining saloon is a spacious apartment at the fore end of the bridge deck, and extends the full breadth of the ship. It is well lighted and ventilated, having large windows on three sides, and a dome skylight overhead. It is panelled in light oak. Adjacent to it is the main staircase, giving access to the music room and to the deck cabins on the promenade deck. The music room is panelled in lincrusta with mahogany framing, and is well lighted by cottage windows. At the after end of the promenade deck is the smoking room, a large and lofty apartment, panelled in oak, with lincrusta panels in the ceiling.

Ample sanitary accommodation is provided, fitted in different parts so as to be equally accessible from any cabin. The baths are fitted with hot and cold water and with douches, and patent heaters are provided on each bath. The dining saloon, music room, smoke room and all state rooms have electrically driven fans, which can be regulated to three speeds, for purifying the air.

The chief galley is on the bridge deck, between the engine and boiler casings, with bakery adjoining. It is fitted with all the latest appliances for cooking. Refrigerating chambers carry the stores for the passengers' consumption.

The officers' and engineers' accommodation is on the after end of the bridge deck. A large chart room and wheelhouse contain the steering wheel and other navigating appliances. The seamen, firemen, stewards and petty officers occupy the poop and forecastle.

The appliances for loading and discharging cargo are very complete. There are five cargo hatches of large size, with ten derricks and nine powerful winches. The vessel is lighted throughout by electricity, including navigating lights and large

Progress of Naval Vessels.

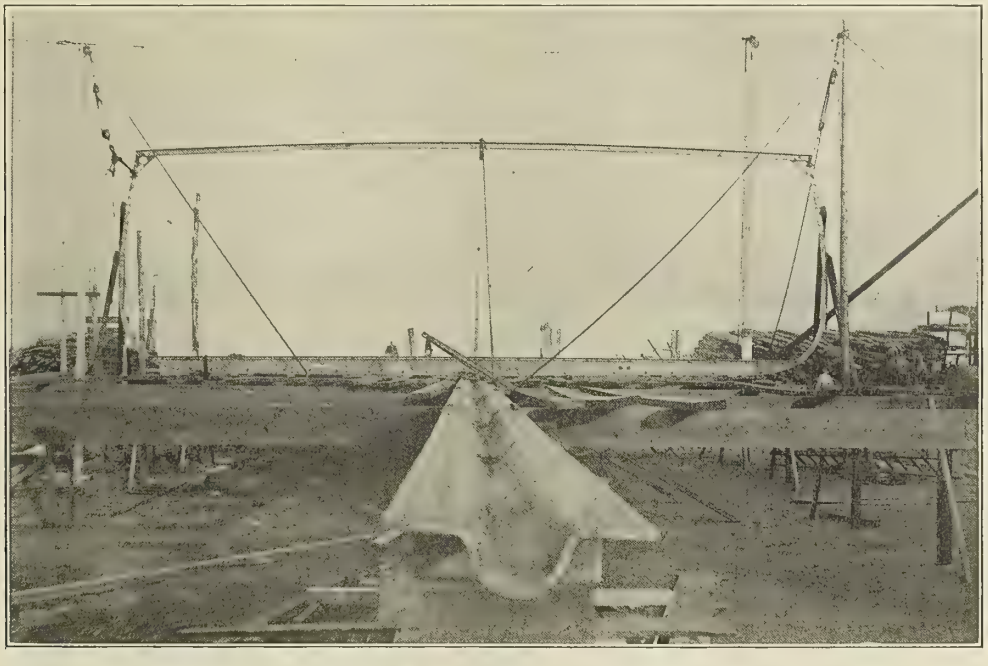
The Bureau of Construction and Repair, Navy Department, report under date of April 10, 1906, the following percentage of completion of vessels building for the United States Navy:

				Mar. 1.	Apr. 1
BATTLESHIPS.					
Virginia	19	knots.	Newport News Co.	99.	99.5
Nebraska	19	"	Moran Brothers Co.	90.	92.
Georgia	19	"	Bath Iron Works	94.59	95.75
New Jersey	19	"	Fore River Shipbuilding Co.	97.5	98.5
Connecticut	18	"	Navy Yard, New York, N. Y.	96.13	97.11
Louisiana	18	"	Newport News Co.	97.19	97.92
Vermont	18	"	Fore River Shipbuilding Co.	76.3	79.3
Kansas	18	"	New York Shipbuilding Co.	74.2	75.7
Minnesota	18	"	Newport News Co.	83.52	85.27
Mississippi	17	"	Wm. Cramp & Sons	51.21	52.84
Idaho	17	"	Wm. Cramp & Sons	49.18	51.44
New Hampshire	18	"	New York Shipbuilding Co.	39.3	40.4
ARMORED CRUISERS.					
California	22	knots.	Union Iron Works	90.	91.9
South Dakota	22	"	Union Iron Works	89.1	89.8
Tennessee	22	"	Wm. Cramp & Sons	94.53	96.37
Washington	22	"	New York Shipbuilding Co.	95.5	96.
North Carolina	22	"	Newport News Co.	37.04	39.97
Montana	22	"	Newport News Co.	32.41	35.4
SEMI-ARMORED CRUISERS.					
St. Louis	22	knots.	Neafie & Levy Co.	90.56	93.37
Milwaukee	22	"	Union Iron Works	90.9	92.5
SCOUT CRUISERS.					
Chester	24	knots.	Bath Iron Works	22.28	26.15
Birmingham	24	"	Fore River Shipbuilding Co.	24.5	28.6
Salem	24	"	Fore River Shipbuilding Co.	24.9	28.9
SUBMARINE TORPEDO BOATS.					
Submarine No. 9			Fore River Shipbuilding Co.	61.	63.9
" " 10			Fore River Shipbuilding Co.	48.9	52.5
" " 11			Fore River Shipbuilding Co	50.9	58.2
" " 12			Fore River Shipbuilding Co	48.3	51.4

THE HENDRICK HUDSON.

Promptly at three o'clock, March 31, the new Albany Day Line steamer *Hendrick Hudson* was launched in the yard of the Thomas S. Marvel Shipbuilding Company at Newburgh, N. Y. This steamer, which is said to be the largest river steamer in the world, is being constructed to accommodate the greatly increasing passenger traffic upon the Hudson, the present day boats being now crowded during the season almost to their full capacity, and in some cases being called upon to transport more people than they can comfortably carry. The Hudson river has long been noted for the magnificent scenery which lines its banks for a hundred miles of its course above the city of New York, the diversity being unequaled, not only in this country but anywhere else on the globe; and it is to afford opportunities for visitors to see this spectacle that the new steamer will be put into service.

The *Hendrick Hudson* has a length over all of 402 feet; a water line length of 390 feet; an extreme beam of hull amidships of 43 feet; a maximum beam over the guards of 82 feet; a depth of hold of 14 feet 4 inches; and a uniform draft of 8 feet throughout the straight portion of the keel. The forefoot is largely cut away, and as our illustration shows, the deadwood at the stern is likewise cut away, allowing the fitting of balanced rudder overhanging the after end of the keel. The contract for the construction of this steamer was placed with the W. & A. Fletcher Company of Hoboken, who are building the boilers and machinery. It is under a sub-contract that the hull has been built, while another sub-contract covering the joiner work has been let to John Englis & Sons, of Greenpoint, Brooklyn.



THE FIRST FRAME IN POSITION, SEPTEMBER 27, 1905. GUTTER KEEL ALSO SHOWN.
(Our photographs are from D. E. Herrick, Newburgh.)

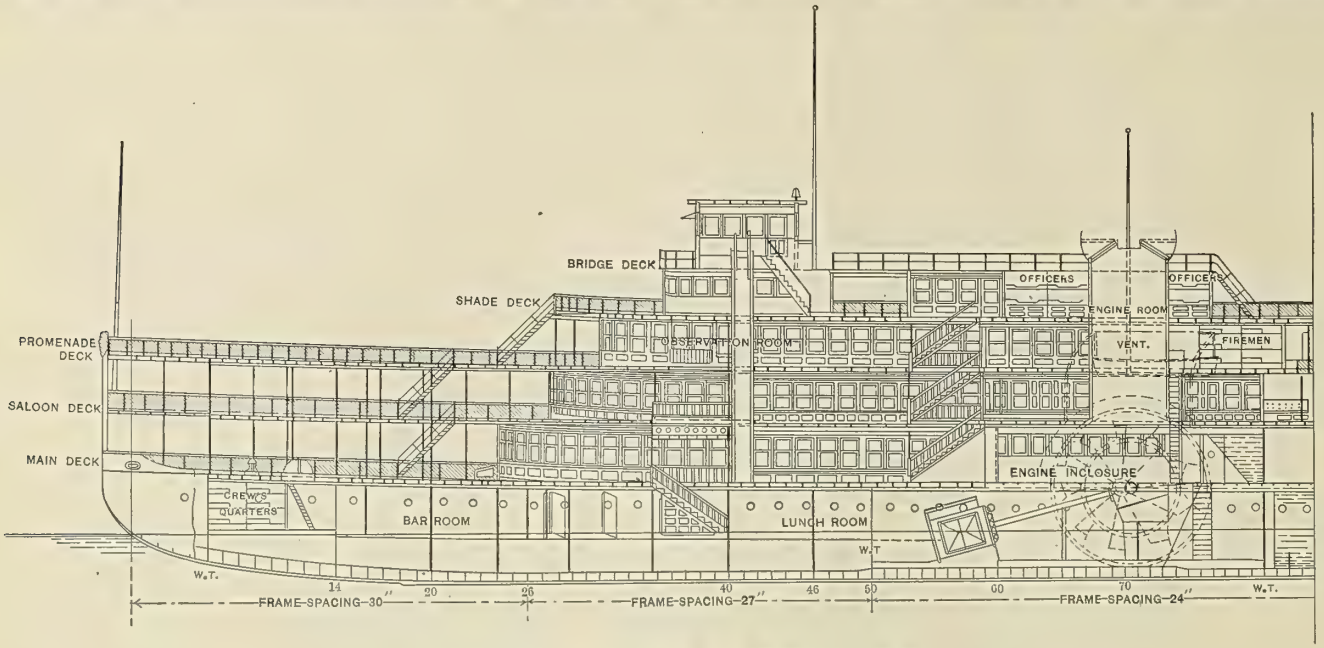
The hull is constructed entirely of steel, while a rigid frame work of the same material acts as a support of the joiner work in the upper part of the boat. This frame work is so designed as to act as a steel girder or truss, thus making it possible to do away with the ungainly hog masts so prominent in the older constructions. Seven steel watertight bulkheads render the vessel practically unsinkable, while all the inclosures around the boiler and machinery spaces are built up of heavy steel plating, thus eliminating practically all danger of fire.

As the engine, which is of inclined three cylinder short stroke pattern, is made direct acting, there will be no walking beam. Another innovation will be the placing of the paddle wheel shaft below the deck, this being made possible by the adoption of paddle wheels of small diameter. This feature will obviate the necessity of dodging under the shaft or climbing over it, as is the case with most of the boats now in service.

In general arrangement, it will be seen from the drawing that there are five decks, of which three are given up wholly to passengers' accommodations, while two of the others are partially so utilized. The bridge deck contains simply the pilot house, and is not available for passengers. The shade deck contains two short deck houses occupied by officers' quarters, the balance of the deck being an open promenade. The promenade deck has large open spaces at bow and stern, together with a narrow passageway along both sides of the boat connecting these two. The remainder of space, occupying nearly two-thirds the length of the boat, consists in two large observation rooms, one forward and one aft, with a narrow portion devoted to the use of firemen and to a light and ventilating trunk between the funnels. Just abaft the after funnel is an open passageway across the deck. The saloon deck has about the same arrangement as the promenade deck, except that, being below the latter, the promenades at bow and stern are covered instead of being open. The main deck has a forward promenade similar to that on the saloon deck, aft of which is an inclosed compartment for passengers, followed by the engine inclosure, a small trimming tank, the boiler inclosure, purser's office, and the large dining room. The lower deck has forward the crew's quarters, immediately in rear of which are the bar room and the lunch room. Then comes the engine room, extending over a length of 62 feet. The boiler compartment covers a length of 74 feet, the coal being stored in wing apartments on either side. Next come galley, serving room and quarters for waiters. There is space below the galley and waiters' quarters aft, as well as below the bar and lunch room forward, for the stowage of stores. No freight whatever will be carried, as the entire space is taken up by accommodations for passengers, etc.; and the weight is likewise entirely allotted to this same purpose.

The observation rooms on the promenade deck are fitted all around with plate glass windows, affording a magnificent outlook

in all directions, while the other inclosed portions of the decks have similar arrangements for observation. A band platform will be suspended in an opening in the saloon deck forward in such a way that the music will be audible on the promenade, saloon and main decks. It is estimated that 3,000 passengers can sit within hearing of the orchestra without crowding. The carrying capacity of the steamer is placed at 5,000 passengers. The speed is 23 miles per hour.



BOW:—LONGITUDINAL SECTION OF THE HENDRICK HUDSON.

THE SCANTLINGS.

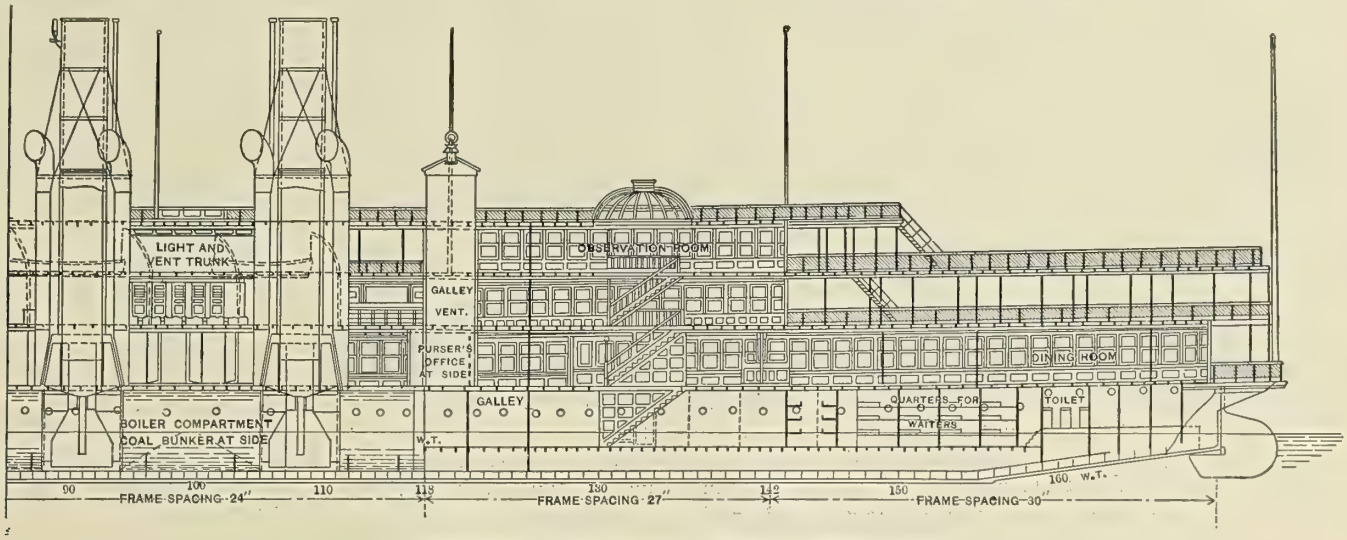
The stem down to the 4-foot water line is a rolled bar of iron measuring 6 by 2 inches; the balance down to the keel measures 4½ by 1½ inches, and has a connection to the keel plate 36 inches long; the stern post is of hammered iron measuring 6 by 4½ inches at the keel and 6 by 7½ inches at the tuck. The head of the post is secured to an 18-pound transom plate. The inclined portion of the keel, between the rudder post and the flat keel, measures 4½ by 1½ inches, and has a 36-inch connection with the keel proper. At the heel of the post is a step for the rudder. The keel proper is of the hollow or gutter type, consisting of a plate of flanged steel 20 inches wide and weighing 22 pounds per square foot, with a 4-inch gutter. The plates are fitted in long lengths, with 22-pound treble riveted butt straps.

The frames are spaced 24, 27 and 30 inches apart, as mentioned above. The only exception to this regular spacing is forward of the collision bulkhead, on frame No. 6, where the 30-inch spaces are sub-divided by intermediate frames into 15-inch spaces. The frames are all of bulb angles measuring 4 by 2½ inches by 8 pounds per running foot, and extend in each case in one length from keel to main deck stringer plate. For a distance of 175 feet amidships doublings of the same scantling and 24 inches long are fitted across the keel, and riveted through the floors to the frames. This connection at the ends of the vessel is made by allowing the frames to lap over the center, where they are riveted to each other. At watertight bulkheads the frames measure 5 by 3 inches by 9 pounds, while abaft the stern post the size is 3½ by 2½ inches by 6 pounds. Reverse frames are fitted only under the engine and boiler spaces, and extend in a single length entirely across the vessel. In the engine room they measure 3 by 3 inches by 7 pounds, and in the boiler room 2½ by 2½ inches by 5 pounds.

The floor plates are 15 inches deep at the center line, except in the engine space, where they are 20 inches deep. In the engine and boiler space they measure 15 pounds per square foot; in the 27-inch frame spacing, 12 pounds; and at the ends of the vessel, 10 pounds. They are worked in one piece across

EXTERIOR VIEW OF BOW FRAMING, WITH SOME PLATING IN PLACE, DECEMBER 14, 1905.

the vessel except in way of web frames. The tops of floors are flanged 3 inches. Limber holes 3 inches in diameter are placed as low in them as possible. At bulkheads the floors are 15 pounds thick and 27 inches deep, while at the ends the depth is increased.



LONGITUDINAL SECTION OF THE HENDRICK HUDSON—STERN.

At frames 83, 87, 96, 103, 112 and 116 the floors are made sufficiently high to be used as boiler saddles. They are fitted here with double 3 by 3-inch by 7-pound angles on top, and with knee plate braces.

Web frames are spaced every six or seven frames throughout the length, and are formed of 10-pound plate 15 inches wide, riveted to the main frames and carrying on the inner edge two 2½ by 2½-inch by 5-pound reverse frames worked continuously across the tops of the floors and up to the deck. At the wheel beams and sponsons three of these web frames are fitted, of 13-pound plate, with double 3 by 3-inch by 7-pound angles on inner edge. The keelsons do not cut the web frame angles, but are carried over them, and fitted with diamond plates.

On each side of center line amidships three keelsons are worked over the floors. Fore and aft of machinery space the center ones unite into a single keelson. They consist of a 5-inch by 12.5-pound Z-bar, a continuous 3 by 3-inch by 7-pound angle and 10-pound intercostal flanged plates to the shell. Connections are made with the floor by clips consisting of 2½ by 2½-inch by 5-pound angles. There are also fitted on each side one bilge stringer and one side stringer, of the same construction as the keelsons, except that the continuous angle in this case is omitted fore and aft of the machinery space. All keelsons unite at the ends of vessel with breast hooks. The side keelsons between wheel beams are 36 inches wide, with double 2½ by 2½-inch by 5-pound angles on the inner edge, and are fitted with diamond plates at web frames. All keelson bars are carried continuously through the transverse watertight bulkheads, and have watertight gravets fitted around them.

THE FORWARD FRAMING AS IT APPEARED DECEMBER 28, 1905.

Deck beams are placed on every frame, and fitted in one length from side to side of hull. They measure 5 by 2½ inches by 10 pounds, bulb angles, for the 24-inch frame spacing; 4 by 2½-inch by 8-pound bulb angles for 27-inch frame spacing; and 3½ by 2½-inch by 6-pound angles at the ends. They are connected to the frames by 12-pound bracket

plates, reduced to 10 pounds for the 3½-inch beams, and extending 18 inches on the frame and 16 inches on the beam. At each end of wheel opening and across the boiler hatch are fitted strong beams. Where the deck beams are cut in way of main deck hatchways a fore-and-aft piece of same scantling as the beam is fitted. Fore and aft of machinery space are hold beams, angles, 3½ by 2½ inches by 6 pounds, on every third frame. Under the galley and forecastle are fitted 10-pound knee plates on every frame. The crown of deck beams is 16 inches in 82 feet.

The shell plates are joggled, with in-and-out strakes, and fitted with butt straps, each plate being more than 18 feet long. The garboard strake measures 18 pounds between frames 25 and 150, and 16 pounds at ends. The sheer strake, which is 33 inches wide, measures 27½ pounds for the half length amidships, and is gradually reduced to 11 pounds at the ends. In way of the wheels, the sheer strake is fitted with a 15-pound doubling plate. The other bottom and side plating for 100 feet amidships weighs 15 pounds per square foot; for a further 70 feet forward and 70 feet aft it is 13 pounds, while the ends are 11 pounds thick. The longitudinal laps of all sheel plate are single riveted except that the garboard connection to the keel and the connection of the sheer strake to that next below it are double riveted. The butts of garboard strake are treble riveted; those of the sheer strake, double strapped and treble riveted for 100 feet amidships double strapped and double riveted for an additional 100 feet at each end, and single strapped and double riveted at the ends. The butts of the bilge strake are treble riveted for 75 feet amidships. All other shell butts are double riveted.

The main deck stringer plate is 36 inches wide and measures 21 pounds for 200 feet amidships. It is gradually reduced at the ends to 30 inches by 11 pounds. Other deck plates are fitted at the wheel opening. The butts of the stringer plates are double riveted, with double straps. The harpin is 3 by 3 inches by 10 pounds, reduced gradually to 8½ and 7-pound angles. Center and side tie plates are 9 inches wide, and fitted in long lengths of 12-pound plate, with butts lapped and treble riveted. Forward of collision bulkhead and aft of frame 168 the deck is completely plated with 10-pound steel, as is also the case on the guards aft of wheels for a space of about 200 square feet on each side of vessel. In this latter case it is stiffened with angles. The lower deck beams under galley are covered with 8-pound plates.

There are seven athwartship steel watertight bulkheads. The collision bulkheads are of 12-pound plate stiffened by vertical angle bars 3½ by 2½ inches by 6 pounds, spaced 24 inches apart, and horizontal bulb angles on opposite side spaced 4 feet 6 inches apart, and measuring 4 by 2½ inches by 8 pounds. The horizontal bars are bracketed to the shell. The other athwartship bulkheads, except at frame 71, are of 11-pound plates worked vertically with 4-inch flanged edges, measuring 2 feet 6 inches between flanges, and with horizontal angle bulbs, 4 by 2½ inches by 8 pounds, 4 feet apart, on other side, connected to shell plating by gussets. The bulkheads are connected to skin plating by 5 by 3-inch by 9-pound angles with double zigzag riveting. Each bulkhead is fitted with a brass sluice valve of about 20 square inches opening, operated from main deck. Sounding tubes are fitted in each watertight compartment.

The guard beams are straight, and are carried out from the hull on a line tangent to the crown of main deck beams. They are 5 by 3 by 3 inches by 11.2 pounds Z-bars, fitted on alternate frames, and with bracket plates to hull; the latter are 21 by 16 inches by 11 pounds, with flanged edges. The beams are fitted with tee braces 3½ by 3½ inches by 9.2 pounds for 200 feet amidships, the balance being 3 by 3 inches by 6.6-pound tees bracketed to shell plating and beams, and tied to beams with a 2½ by 2½-inch by 5-pound vertical angle carried for about 200 feet amidships. Between the steel guard beams are intermediate guard beams of 5 by 3½-inch yellow pine, with angle clips fitted on outboard ends connecting to wale piece.

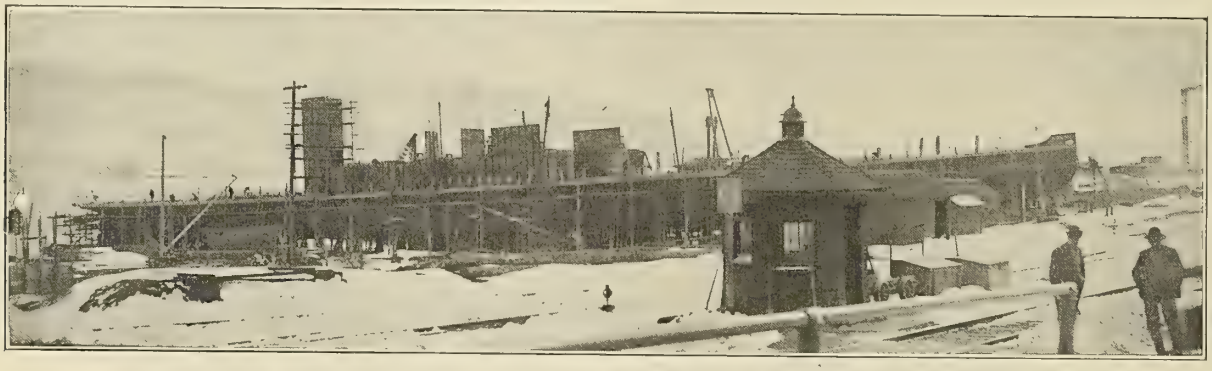
There are three trussed wheel beams on each side, made up of 15-pound plates and 3 by 3-inch by 7-pound angles. The sponsons for the shaft pillow blocks consist of 20-pound knee plates, 25-pound top plates, 20-pound doubling plates, 20-pound and 8-pound bottom plates, 3 by 3-inch by 7-pound web angles, and 6 by 3½-inch by 15-pound top angles.

The engine and stack inclosures have coaming plates 12 inches high of 13-pound steel, the casing from main to shade deck being 8-pound plates, with 6-pound plates above the shade deck. This casing is stiffened inside with 3½ by 3-inch by 6-pound tee bars forming seam straps.

The rudder is of the balanced type, with frame, stock and arms forged in one piece of hammered iron, there being one cross arm and one diagonal arm. The stock measures 7½ inches in diameter at the head, reduced at the heel to 4½ inches. Side plates are of 11-pound steel. The rudder quadrant consists of a cast steel hub double bored and fitted to rudder stock by a key; it measures about 4 feet in radius to rim, which has the usual trough for steering chains.

The hull and side lights have composition frames, double hinges and single clamps. There are one hundred and twenty 10-inch lights and fourteen 8-inch. In addition there are ten escape ports measuring 10 by 18 inches in the clear, enabling the escape through them of any person who might be caught below in such an accident as that in the North German Lloyd steamers, in June of 1900.

The main deck plank is of clear Oregon pine in strips 2½ by 2½ inches. The plank sheer of white oak 14 by 3 inches; clamp, white oak, 12 by 3 inches; wales, white oak, 11 by 6 inches, with beveled joints. There is a facing wale of iron 10 by ¾ inches. The main rail is of yellow pine 6½ by 2½ inches; stanchions of oak spaced 42 inches apart, and measuring 3½ by 3 inches at bottom and 3 by 3 inches at top. Coamings on main deck are of yellow pine.



THE HULL OF THE HENDRICK HUDSON, MARCH 16, 1906, FIFTEEN DAYS BEFORE THE LAUNCHING.

THE MACHINERY.

The steamer will be propelled by a pair of paddle wheels actuated by a three cylinder compound engine, which is directly connected to the shaft without the intermediation of the customary rocking beam. These cylinders are arranged with the high pressure in the middle and have diameters respectively 70, 45 and 70 inches, the common stroke being 7 feet. The high-pressure cylinder has two balanced slide valves of a modified gridiron type, while each low-pressure cylinder has a single three-ported slide valve balanced by steam pressure on the back. The main steam inlet has a diameter of 14 inches.

The paddle wheels have a diameter over all of 24 feet, and are of the feathering type, with nine buckets each; the latter have a width of 4 feet and are 14 feet 6 inches long. The number of revolutions under full power (5,500 horsepower) will, it is anticipated, be 40 per minute. The shaft is of open hearth carbon steel measuring 18½ inches at the engine, and expanded to a diameter of 22 inches where it passes through the hubs of the wheels. Crank pins have a diameter of 18 inches, the throw being 42 inches. The flanges of the paddle wheel hubs are formed of solid steel castings, the arms being of wrought iron and offset. Connecting rods measure 16 feet 6 inches between centers.

donkey fire pump has cylinders 12 and 9¾ inches by 12 inches stroke.

There are four single ended and two double ended boilers, the latter being designed with independent combustion chambers; all are made to the same pattern, being 12 feet 4 inches in mean diameter and fitted with two furnaces in each of the single ended and two furnaces in each end of the double ended boilers. The furnaces are of the Morison suspension type, with an inside diameter of 44 inches. Anthracite will be burned in them. The boilers are respectively 11 and 22 feet in length, and are fitted with 2½-inch tubes. The aggregate grate surface is 424 square feet, while the heating surface, which bears a ratio to the grate of about 36 to 1, is 15,250 square feet. The steam pressure is 170 pounds per square inch. Forced draft is furnished under the Howden system, there being two Sirocco blowers with 51-inch wheels, operated by Fuller engines.

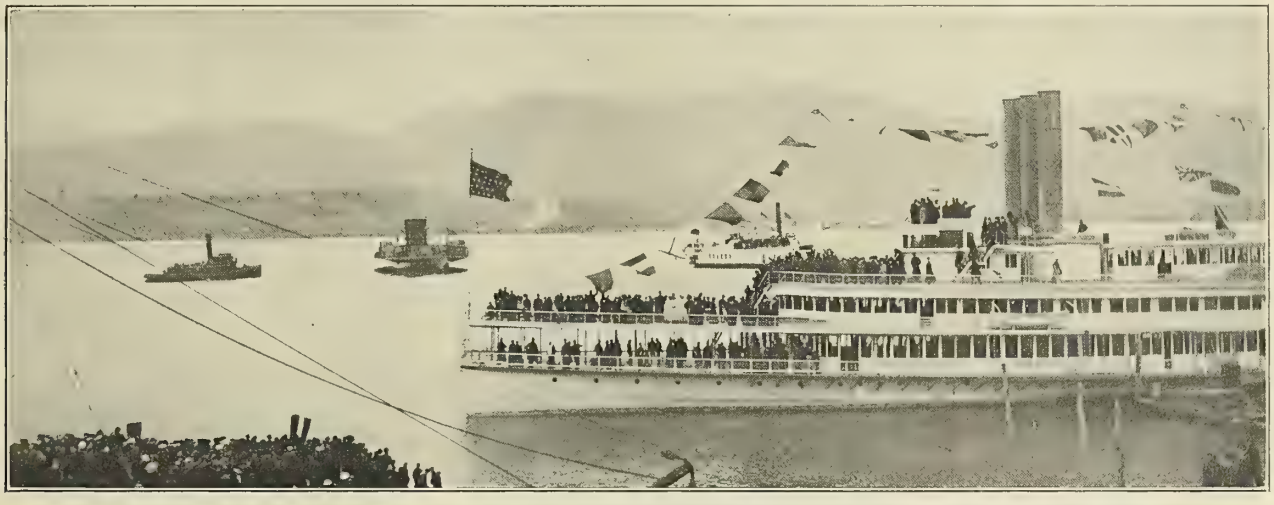
There are two 25-kilowatt generating sets from the works of the General Electric Company, operated by Curtis turbines direct connected, and furnishing direct current at a pressure of 110 volts. Steam steering gear will be fitted, with hand gear for relay.

THE FITTINGS AND DECORATIONS.

The interior finish of the dining room and of the grand saloons will be mahogany throughout, and the finish of the main deck forward of the dining room will be French gray oak, while the splendid obversation rooms will be finished in clear cypress, with dull green stain, all highly polished. A handsome dome of stained glass will top the upper grand stairway in the after cabin. There will be a number of special day parlors of large size arranged on either side of the saloon deck cabin, and two similar rooms on the shade deck, directly underneath the pilot-house. The two last named rooms will be decorated in Louis XVI style, finished in ivory enamel and gold. Those on the saloon deck will be decorated and furnished in the following distinct styles: Two Japanese rooms; four in the modern Art Nouveau style, in quartered oak, with unique decorations; two Dutch rooms, in oak, decorated in characteristic manner; two French Empire rooms, in mahogany and gold; and two rooms in the Colonial style, finished in poplar and mahogany. There will also be ten smaller rooms, handsomely decorated. A large and completely equipped teakwood writing room in the Persian style of decoration will be conveniently located for the passengers' use.

Among the mechanical fittings might be mentioned the Nicholson ship log; while the safety of passengers is secured by the usual equipment of life preservers and boats, and by eight Carley life floats, 6 by 10 feet in size.

The first trip is scheduled for August.



JUST AFTER LAUNCHING, MARCH 31, 1906. STEAMER NEW YORK IN FOREGROUND. HENDRICK HUDSON IN MIDDLE DISTANCE.

The main bearings, four in number, are 16 inches long, with outboard bearings 18 inches in length. The boxes are of cast iron lined with babbitt metal. The crank pin boxes are of cast steel and are of the Scotch type, while the crosshead boxes are bronze, of the locomotive type with straps.

The crosshead pins, which have a diameter of 11 inches, are of open hearth carbon steel. The slides, acting as struts between the cylinders and the shafting, are also of open hearth carbon steel, and are six in number, two to each cylinder. The sliding faces are 12½ inches wide and the columns have a diameter of 8 inches. The crossheads and shoes are steel castings, the slippers being lined with babbitt metal and having a bearing surface measuring 12½ by 26 inches. All the engine castings are of steel, the bedplate being very light because of the excellent foundation built up from the frame work of the vessel itself.

A single surface condenser with 8,000 square feet of cooling surface has a diameter of 75 inches, and is fitted with ⅝-inch tubes measuring 14 feet 2¼ inches in length. The air pump is independent, of the Blake twin pattern, the air cylinder having a diameter of 28 inches. A centrifugal pump is fitted, furnished by the Morris Machine Works of Baldwinsville, N. Y. The main feed pump is also of the Blake pattern, being compound simplex with steam cylinders 14 and 20 inches and water cylinder 12 inches in diameter, and a common stroke of 18 inches. A

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Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 8th of the month, to insure the carrying out of such instructions in the issue of the month following. If proof is to be submitted, copy must be in our hands not later than the 1st of the month.

The edition of the May issue of International Marine Engineering *comprises 6,500 copies. We have no free list, accept no return copies and issue only enough to supply the regular demand, so that the 6,500 copies represent legitimate circulation.*

Our Change in Name.

The rapidly increasing dimensions of our foreign business, together wth an appreciation of the extremely high position in the shipbulding line enjoyed by Great Britain, have led us to embark upon the publication of an English edition, which will be issued in London coincidently with the regular edition in New York. With the liveliest anticipations of an immensely increased patronage under the headings of both readers and advertisers in the British Isles, we have considered it best to become international in name as well as in fact, and hence have prefixed the word "International" to the previous name Marine Engineering, and will hereafter be known as International Marine Engineering.

There will be no change in our policy, which is, as it has ever been, to bring before our readers in a clear and concise manner everything of a marine or shipbuilding nature which might seem to be of interest to them, each and every item being taken up with as much attention to engineering details as possible. We expect to continue along these lines, improving month by month as much as may be, but following out in the main the schedule which has been found so successful heretofore.

In this connection, we will always welcome suggestions from readers, both as to policy and as to details, and trust that each of our friends will continue to feel at liberty to let us know whenever he has anything to suggest, either in the way of some construction which ought to be described, or in connection with any other item of interest.

The Powering of Battleships.

One of our articles this month describes at some length the trial trip of the battleship *Louisiana* and is noteworthy not only because of the large amount of information and data contained within itself, but also by reason of the side light which it throws upon results obtained from previous ships. What is necessary for an analysis of comparative results in this connection are figures for displacement, horsepower and speed on trial, with which might be included similar figures as estimated in the design. The *Louisiana* has a displacement of 16,000 tons, and was designed to obtain a speed of 18 knots with 16,500 horsepower. The result on trial was 18.823 knots with 20,443 horsepower.

The two ships with which we propose to compare this result are the *Virginia,* trial of which was described in our issue for March of this year, and the historic *Oregon,* which was tried more than ten years ago. The *Virginia* has a displacement of 14,948 tons, and was designed for a speed of 19 knots with the engines indicating 19,000 horsepower. The trial speed of 19.01 knots was obtained with 22,501 horsepower. The *Oregon* had a trial displacement of 10,242 tons, and was designed for a speed of 15 knots with 9,000 horsepower. The result obtained on trial was a speed of 16.79 knots with 11,037 horsepower.

The method of comparison in cases of this sort is to determine what is known as the Admiralty constant or Admiralty coefficient; this figure being based upon the two-thirds power of the displacement, multiplied by the cube of the speed, and divided by the horsepower at which the speed was attained. For the *Louisiana* this figures out at 220.4 under trial conditions, while the design called for 224.5. For the *Virginia* the design called for 219.5 and the result obtained was 185.5. With the *Oregon* the design called for 176.6 and the result obtained was 202. It might be mentioned in this connection that the hull of the *Oregon* was not subjected before her construction to model tests designed for the purpose of determining the best form for the results desired. That of the *Virginia* was so tested, but not to the same extent as was the case with the *Louisiana,* and as a result the latter ship has shown a much higher degree of performance, and a performance considerably superior to that of the *Oregon.* This is true not only in connection with the relation between hull, speed and power, but also in connection with the relation between the coefficient as designed and the coefficient actually obtained on trial.

In the *Louisiana* the coefficient on trial was somewhat less than that designed, which indicates that the performance was not quite so good as was anticipated. The difference, however, is so slight that the designed speed of 18 knots would have been attained under the same conditions as were observed in the trial of the ship, with 16,830 horsepower, as compared with 16,500 horsepower in the design. This increase of 2 percent indicates a very close agreement between design and result.

With the *Virginia,* the anticipated coefficient was very largely reduced when it came to practice, and as a result the designed speed of 19 knots was found to require 22,465 horsepower for its development, in place of the 19,000 called for by the design.

The *Oregon,* on the other hand, showed a marked superiority in performance over the design. The coefficient was increased from 176.6 to 202, and as a result the designed speed of 15 knots could have been attained with 7,860 horsepower as compared with 9,000 in the design.

When it comes to a comparison of the *Louisiana* with the other two, we find that the speed actually attained by the *Louisiana* would have required on the basis of the performance of the *Virginia* 24,230 horsepower. On the basis of the *Oregon's* performance, the requirement is 22,270 horsepower. There are thus savings respectively of 3,800 and 1,800 horsepower as compared with the two previous ships, an eloquent testimonial in favor of the value of systematically conducted model experiments as performed under the conditions available with the splendid equipment in the Navy Yard at Washington.

The results obtained by the *Oregon* were extremely good, not only for her type, but also for the date at which they were made. It is thus a case for congratulation that a later ship has been able to make a distinct saving on these results, as the *Louisiana* has done.

It is of course understood that this method of figuring comparative results is not always strictly applicable, because of the fact that, other things being equal, increase in size of ship conduces to an increase in the coefficient and an apparently better result under given conditions. On the other hand it may be stated that, other things being equal, an increase in the speed of the ship will produce a decrease in the coefficient and indicate an apparently less satisfactory result than with a lower speed. Minor conditions affect very markedly both of these considerations, as may readily be seen when the speed-power curve of a vessel is examined and the positions of its humps noted. On pages 286 and 289 of our issue for July, 1905, are shown curves of this sort in which the humps are very marked. It is needless to state that their positions and extent depend upon the length of the ship, and upon the form of the afterbody. Without such data to utilize it would, of course, be out of the question to attempt a thorough comparative analysis as between two or more ships, but the method adopted above is satisfactory in most cases, and will serve to show clearly the character of the results achieved during the last few years.

As indicating the increased efficiency of performance with decreased speed, figures might be taken from the speed-power curve of the *Louisiana* as completed, showing that at 16 knots the requirement was for 9,400 horsepower, giving a coefficient of 276.2; at 17 knots, with 12,350 horsepower, the coefficient is 252.6 and at 18 knots, with 15,850 horsepower, a coefficient of 233.3 is obtained. At the attained speed of the *Oregon,* 16,79 knots, the horsepower called for by the *Louisiana* is 11,650, with a coefficient of 253.8; this result is seen to be decidedly superior to that obtained with the *Oregon,* the power for a ship 50 percent larger in displacement having been increased by less than 6 percent, as compared with a theoretical 31 percent.

Fireproof Construction in Steamboats.

Late in March the Fall River Line steamer *Plymouth,* which was undergoing overhauling at Newport, was burned under circumstances which seem to call for an immense improvement in the construction of craft of this sort. It may be out of the question to render any such structure or vessel entirely fireproof, and even if this were not the case, it would probably be found inexpedient to incur the expense and other disadvantages which would be involved. In this case, however, the spread of the fire was so extremely rapid that a man was burned in his bunk (the fire occurred at night) and several other members of the force on board had considerable difficulty in effecting an escape. It would thus seem to have been simply a providential interposition in that the vessel was not heavily loaded with passengers, which prevented a repetition of a catastrophe similar in character, though possibly not in magnitude, to that which overtook the *General Slocum* two years ago. It is true that the *Plymouth* was a comparatively old vessel, she having been constructed in 1890, but this fact is no excuse for the existence upon her of conditions which gave rise to so extremely rapid a spread of fire. Every vessel of this sort, the upper works of which are in nearly all cases constructed almost entirely of wood, ought in all cases to be fitted with effective fire breaks in the shape of vertical transverse bulkheads of steel, extending continuously from the keel to the topmost deck, and provided with only a sufficient number of openings to permit easy access between the several portions of the vessel. This sort of construction would involve only a trifling increase of expense, and would afford immense additional security, not only to the passengers and crew on board, but to the vessel as a whole, because it would confine a sudden fire to a single compartment at least long enough to enable effective means to be employed in fighting it. It would in this case act in the form of a preventive insurance, and might easily in a short period more than pay for itself in the security afforded.

This construction is to be used to some extent on the new steamer *Hendrick Hudson* of the Albany Day Line, but in general the magnificent steamboats upon our sounds and rivers are entirely without fire protection of any sort.

ABSTRACT FROM RULES AND REGULATIONS OF BUREAU VERITAS.

EDITION OF 1905.

ARRANGED BY HARRISON S. TAFT.

PART I.

1. Measurements.

TABLE I.—MEASUREMENTS FOR SCANTLING NUMBERS.

Type of Vessel	Length L	Breadth B	Depth—D— for Regulating		
			Athwartship Number	Longitudinal Number	Equipment Number
1. All Single Deck Vessels with but one laid deck with or without a second tier of beams.	From after side of the stem to the fore side of the stern post (rudder post in screw vessels) on line of the upper deck in one and two deck vessels, but on line of the second deck in vessels with more than two decks.	Maximum Molded Beam	Molded to Upper Deck	Molded to Upper Deck	Molded to Upper Deck
2. All Two and Three Deck Steam Vessels having two or more tiers of beams, with at least two laid decks, one of which is of metal.			(a) Molded to Upper Deck	85% of Molded to Upper Deck	Molded to Upper Deck
(a) Trading round the world in all seas and of over 250 gross tons.			(b) Molded to Upper Deck	75% of Molded to Upper Deck	Molded to Upper Deck
(b) Engaged in general coast trade and of or above 70 tons.			Molded to Second Deck	Molded to Second Deck	Molded to Upper Deck
3. Spar Deck Vessels. (See section 33, paragraphs 2 and 6.)			Molded to Second Deck	As taken in Three Deck Vessels	Molded to Second Deck
4. Awning Deck Vessels.			Molded to Upper Deck	Molded to Upper Deck	Molded to Upper Deck
5. Raised Deck Vessels. (See section 35, paragraph 2.)			Molded to Upper Deck	Molded to Upper Deck	Molded to Upper Deck
6. Sailing Vessels. (Without a third tier of beams.)					

Depth to be measured from top of keel to top of above stated decks at side of ship amidships.
Scantling Numbers—Athwartship: AN = B + D. Longitudinal: LN = L × B × D. Equipment: EN = L × B × D + ½ the capacity in cubic feet of the erections on deck.

1. SCANTLINGS UNDER ATHWARTSHIP NUMBER; Frames; reverse frames, floors, bulkheads.

2. SCANTLINGS UNDER LONGITUDINAL NUMBER; Stems; stern posts; bar keels; flat plate keels; shell plating; frame spacing; rudder head, heel and pintle; all keelsons; wood ceilings; members of double bottoms; hatch coamings, poop, forecastle, deck houses; casings.

3. Scantlings of Beams are regulated by midship length of the beams.

4. Scantling of decks, stringers and ties are regulated by length and depth only.

5. A reduction of ⅓ will be allowed on the equipment number as found by the above formula for the anchors and chain cables of full powered steamers. Stockless anchors are to be 25 percent heavier than otherwise, the weight of the shank being not more than ⅓ of the total weight of said anchors.

Note: The name upper or first deck refers in all cases to the uppermost or weather deck, whatever category the vessel may belong to: i. e., in spar deck vessels to the spar deck, in awning deck vessels to the awning deck.

2. Scarphs.

Scarphs of all bar keels, stems and stern posts should be in length not less than three times the required depth of the bar keel.

3. Stems.

Stems are to be of the same scantling as the bar keel. They should maintain their full sectional area up to the light load water line, with a gradual reduction above said line to their head, where the sectional area can be ⅔ that of the tabular area.

4. Stern Frames.

1. In sailing vessels, paddle and twin screw steamers, the stern frame should equal the scantling of the bar keel, with an increase over said scantling at the gudgeons if necessary. The sectional area of the stern frame can be gradually reduced above the counter so that it will be at least ⅔ of its greatest sectional area.

2. SINGLE SCREW VESSELS.

(*a*) PROPELLER POST.

That part of the propeller post above the boss can be gradually reduced, so that it will be of the same size as the rudder post at its junction with the same. The thickness on each side of the boss is to be at least ⅔ of the thickness of the lower part of the propeller post.

(*b*) RUDDER POST.

The sectional area of the rudder post is to be at least 90 percent of that of the propeller post. It can be gradually reduced in size from the lower part of the rudder trunk to its head, where its sectional area can not be less than ⅔ of the sectional area at the keel.

(*c*) That part of the stern frame between the two posts must have a sectional area equal to that of the propeller post.

3. The head of the stern frame should be securely fastened to the main deck beams by means of a transom plate. In all screw steamers the propeller post must be carried up and securely fastened to the second deck beams when the steamer's longitudinal number is 210,000 or above.

4. That part of the stern frame forming the after part of the vessel's keel should in all vessels extend forward of the propeller post, with a gradual taper to the size of the bar keel at its junction with the same, for a distance of at least 6 feet when the longitudinal number is under 140,000, but at least 8 feet when said number is over 140,000.

5. The gudgeons are to be spaced from 4 to 5½ feet apart, but never more than the latter. The thickness on each side of the pintle holes is to be at least ½ the diameter of said pintle, the depth of the gudgeons being at least 1¼ times said diameter.

6. The sectional area of the propeller brackets or struts of twin screw vessels should be about 40 percent of that of the shaft which they support.

5. Flat Plate Keels and Center Line Keelsons.

1. Flat Plate Keels with a Vertical Center Line Keelson.

(*a*) Said keel plates are to maintain their midship scantling for one-half length amidships. When they are over 25 pounds amidships their weight at ends must be not less than 5-6 of their midship weight. No reduction from midship weight will be allowed at the after end of screw steamers.

(*b*) When the longitudinal number is 450,000 and above, the flat plate keel is to be worked double for its entire length, the doubling plates being of the same thickness as the garboards.

(*c*) Said keels are to be fitted with a continuous or intercostal vertical keelson in all cases; a continuous keelson having a double angle bar (worked continuously) connection to said keel plates; an intercostal keelson being secured to said keel plates by double intercostal clips.

2. Center Line Through Plate Keel and Keelson.

Said keel and keelson must at least be equal in depth to the depth of the midship floor plates plus the required depth of the bar keel, and have side plates fitted below the floors. The depth of said side plates is to equal the depth of the tabulated bar keel, being of such a thickness that their combined thickness and that of the center keelson plate will not be less than that of the ordinary bar keel in lieu of which this form of connection is used.

3. Center Line Girder Keelsons on Top of Floors.

(*a*) Said girder keelsons are to consist of a vertical plate embraced by two top and bottom angles. A rider plate is to be worked on top of the two upper angles for ¾ length amidships.

(*b*) When the height of said keelsons is over 18 inches it shall be secured to a horizontal plate stringer riveted to top of floors on the center line, said stringer extending as far fore and aft as possible. If said horizontal plate is used when the height of the center keelson is under 18 inches a reduction can be made in the scantling of said girder keelson.

(*c*) Said girder keelson is to be of increased scantling wherever a mast is stepped on same.

4. Continuous Center Line Keelsons.

(*a*) All continuous keelsons under paragraphs 1 and 2 above are to extend as far forward and aft as practical, being worked continuously through all bulkheads, except the two peak bulkheads. They are to maintain their midship scantling for at least ⅔ length amidships with reduction of ⅓ in weight at ends beyond the fore and mizzen mast steps.

(*b*) When said keelsons under paragraphs 1 and 2 (above) extend above top of floors, a horizontal stringer plate, equal to weight of floors and in breadth not less than ¾ the depth of said floors, must be worked on top of floors on each side of the center keelson, being secured to said keelson by two continuous angle bars riveted back to back on top of said stringer plate and embracing the top of said center keelson plate.

(*c*) When said keelsons under paragraphs 1 and 2 (above) are worked flush with top of floors there is to be a center line horizontal plate stringer, equal to the weight of said center line keelson and in breadth at least 1½ times the depth of floors, on top of floors at center line; said horizontal plate being secured to the top edge of the center keelson by two continuous angle bars.

5. Intercostal Center Line Keelsons.

(*a*) When said keelson under paragraph 1 (above) extends above tops of floors it is to be worked as stated under paragraph 4-*b* (above), except that the thickness of the horizontal plate stringer is to equal that of the intercostal keelson.

(*b*) When said keelson under paragraph 1 (above) is finished flush with top of floors, it is to be worked as stated under paragraph 4-c (above) except that the thickness of the horizontal plate stringer is to equal that of the floors.

(c) Intercostal center line keelsons are to have a double clip connection to floors.

6. Frames.

1. Frames are to maintain their midship scantling for ½ length amidships, with a reduction at ends. No reduction will be allowed forward of said ½ length when the transverse number is 71 and over.

2. All frames are to extend in one length from the center line to the upper deck stringer in all vessels except awning deck vessels, and in way of poops, bridgehouses, and forecastles, where the frames are to extend to the stringers of said decks or to the lower part of a rounded gunwale if used.

3. Scarph pieces of the same scantling as the frames, and of sufficient length to allow of three rivets in each flange on each side of the butts, are to be worked across the line of keel for ¾ of the vessel's length amidships. They are to be roved through a "Center Line through plate keel and keelson," but need not be used when a flat plate keel is adopted.

4. In vessels with a speed of 14 knots and over, the frames abaft the stuffing box bulkhead of the stern tube should be worked double at least up to the lower deck; or an intercostal plate stringer chocked to shell may be substituted.

5. In vessels with their machinery located aft, the frames in the machinery space and coal bunkers are to be of midship scantling.

6. At watertight decks or flats it is recommended that the frames with their reverse frames be cut, with knee brackets fitted on both sides of the stringer plates to connect the interrupted frames thereto.

7. Frames at all watertight bulkheads are to be worked double. Single frames may be used if both flanges are wide enough for double riveting.

8. For vessels navigating in ice the frames from the stem to 2 frames abaft the forward collision bulkhead must not exceed ⅔ of their midship spacing.

9. The vertical flange of the frame bar on solid floors within a double bottom may be of the same width as the shell flange.

7. Floor Plates.

1. A floor plate is to be fitted to every frame, being secured to a continuous or intercostal center line keelson by double clips equal to the reverse frames. They are to maintain their midship weight for ½ length amidships, being reduced at the ends. In full form vessels the floors at the forward end should not be reduced more than 1-32 inch for about 15 percent of the vessel's length abaft the collision bulkhead, whether the vessel has a double bottom or not.

2. Floors are to extend up the bilges above the base line to at least twice their center depth amidships for the greatest possible length. At the lower turn of the bilge they should not be less than ½ their center line depth. Towards the ends of the vessel they may gradually be reduced in height at the bilges until they become straight on their upper edge. At the very extreme ends their depths should be increased. In the aft peak of screw steamers they should be of extra depth so as to securely stiffen the after body.

3. All floors in the machinery space and coal bunkers are to be of increased weight.

4. Bulkhead floors are to be deep enough so as to allow the bulkhead plating to be riveted to them above the ceiling and also to fit the keelson collars clear of said landing.

5. Suitable limber holes are to be cut in all non-watertight floors, longitudinals, and wash plates so as to provide for a free flow of water to the pumps.

6. Transom Floors.

On middle line they are to be at least 1½ times the depth of midship floors, but of the same weight. They are to be securely fastened to the head of the stern frame.

8. Reverse Frames.

1. A reverse frame is to be fitted to the top of every floor. They are to maintain their midship scantling for ½ length amidships. They should be fitted in one length, with their butts at the center line well scarphed with an angle clip of the same sectional area as the reverse frames, having at least three rivets in each flange on each side of the butt.

TABLE 2.—EXTENT OF REVERSE FRAMES.

Type of Vessel	Depth	Under 12½ ft.	12½ ft., under 14½ ft.	14½ ft. and above
In General	Extent of Reverse Frames	To Upper Deck and to Upper Turn of bilge alternately	To Upper Deck and to above the Side Stringer Angle Bar alternately	To Upper Deck and to above the Second Deck Stringer Angle Bar alternately
Awning Deck Vessels	Longitudinal Number	Under 270,000	270,000, under 450,000	450,000 and above
	Extent of Reverse Frames	A to top of the Second Deck Stringer Angle Bar	To Awning Deck Stringer on every fourth frame. Others to Second Deck as before	To Awning Deck Stringer and to top of the Second Deck Stringer Angle Bar alternately
Spar Deck Vessels	Extent of Reverse Frames	1. To Upper Deck and to above the Second Deck Stringer alternately. 2. In vessels whose longitudinal number is under 187,500 and having only light deck houses, all reverse frames are to extend up to the spar deck throughout the length over which said deck houses extend, unless partial bulkheads are fitted between decks.		
Sailing Vessels		All to Upper Deck in vessels of 21 or more feet depth to said deck.		
Side Wheel Steamers		All to Upper Deck Stringer in way of paddle boxes; or other stiffening in lieu of said reverse frames.		

2. No reverse frames will in general be required in poops or bridge houses unless there are erections upon said decks. They can also be omitted in top gallant forecastles unless there is danger of said forecastle being damaged by the seas.

3. In coal bunkers and in machinery spaces the reverse frames are to be worked double on every floor, those in the way of coal bunkers being the same thickness as the frames. Said doubling is to extend to the lower turn of the bilge in steamers of less than 16-foot depth, but to the upper turn of the bilge in all other steamers, except in double bottom vessels, where said doubling need not extend beyond the margin plates.

4. Compensation must be made where reverse frames are cut at a watertight flat.

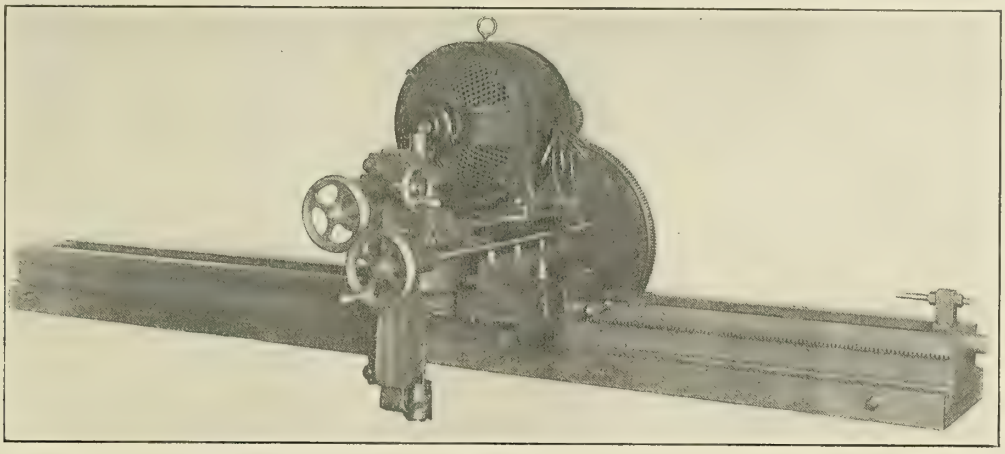
5. (*a*) When a center line keelson extends above top of floors as stated under section 5, paragraph 4 the reverse frames which are cut at said keelson must be scarphed by an angle lug roved through said keelson, the lug being in length equal to the combined width of the two horizontal plates on top of floors.

(*b*) When the center line keelson is worked flush with the top of floors the above scarph pieces can be omitted, but reverse angle lugs, equal in length to at least ½ the breadth of the stringer plate on top of floors at center line must be worked in their place on top of floors on each side of the center keelson.

ENGINEERING SPECIALTIES.

Underwood Portable Milling Machine.

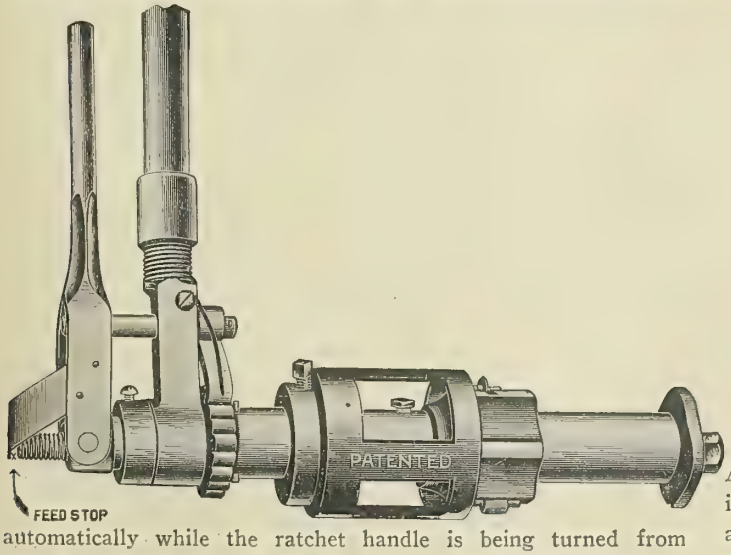
One of the special tools recently placed upon the market by H. B. Underwood & Company, 1025 Hamilton street, Philadelphia, Pa., is a portable milling machine, which is an outgrowth from a temporary rig which they had to devise to do a certain job in place on a large machine. This miller is designed for straight line work of a maximum length of 8 feet, with a number of surfaces in line but on different planes. As shown in the illustration, it is driven by an electric motor, and can be so utilized as to work on a machine after all the parts are assembled. The carriage has a travel of 8 feet, with automatic feed, and the cross slide has a range of 12 inches, the vertical spindle being movable through a distance of 10 inches. The bed is mounted on a sub-base, allowing accurate adjustment by set screws before starting work, while the sub-base is secured to the work by means of clamps or bolts bearing in slots in the usual manner.



Ideal Self-Feed Tube Cutter.

The accompanying illustration shows the Ideal self-feed tube cutter, built by Gustav Wiedeke & Company, Dayton, Ohio. With this cutter tubes can be cut off either inside or outside of the boiler head, and the manufacturers claim that it has solved the problem of cutting off steel tubes without cracking them. The tool is simple in construction and needs very little explanation.

When cutting off tubes, the feed handle is put on the stud parallel with the ratchet handle; the feed handle feeds itself automatically while the ratchet handle is being turned from left to right, in cutting off the tubes. All tubes are usually cut off before the feed rod touches the angle-iron on the feed handle. This tool cuts off all the tubes the same distance from the head, and can be set for any distance, no matter if the tubes project from ½ to 4 inches from the boiler head. It cuts them off with a bevel ready for beading, and rolls the tube at the same time, which is a great advantage. All the change necessary to be made from cutting off tubes from the outside to cutting off on the inside of the head is to move the cap back. This can be done in half a minute.

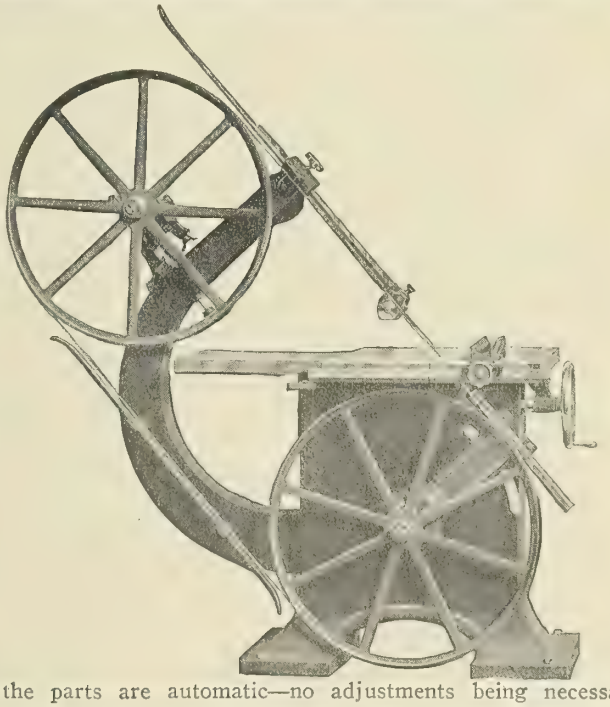


The body of the tube cutter, and all the small parts are made of steel, which limits wearing and prevents breaking. Turning is by means of a ratchet, very simply made. The feed handle is swivelled in order to get close to the boiler shell.

The Crescent Angle Band Saw.

The advantage of a band saw on which the table is always level, but which admits of tilting the saw for bevel work, is at once apparent; since it is so much easier to handle the work on a level table than on an inclined one. On large work it means the saving of an extra man helping to hold the work, while the smaller work can be turned out more accurately and in less time.

A new machine that is said to be thoroughly practical has been developed by the Crescent Machine Company, Leetonia, Ohio.



All the parts are automatic—no adjustments being necessary in changing the angle of the saw. The entire operation is accomplished by simply turning the handwheel at side of table until pointer indicates the desired angle on the graduated quadrant on the pedestal; and this may readily be done while saw is in motion. The location of the drive-pulley is not

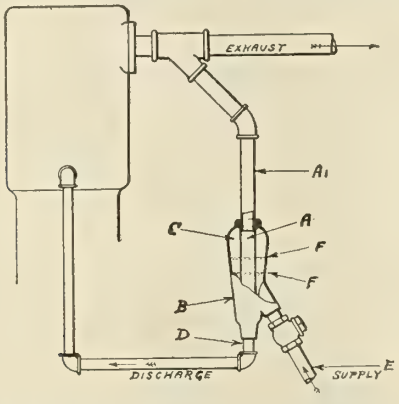
changed. The table is carried back on the pedestal in exact unison with the saw, so the saw keeps its proper position in the saw-slot. Both the lower and the upper guide are kept in alignment with the saw. The tension of the saw does not change.

The arm is hinged to the pedestal in a very rigid manner by means of a heavy trunnion passing through them, concentric with lower shaft, making the machine just as rigid when tilted as when standing erect. The bearings for lower shaft consist of solid bushings fastened into trunnion, and are provided with oil-chamber and capillary felt, making them practically self-oiling and dust-proof. The upper bearing is made with revolving shaft running in adjustable bearings. The table slides on the planed ways of the pedestal, and is provided with a steel gib for taking up possible wear. The saw will tilt back to an angle of 45 degrees, a stop being provided at that point; it may be also tilted forward to 4 degrees beyond the perpendicular. A stop is provided on the perpendicular point, but this stop can be swung out of place at will.

An Exhaust Operated Pump.

Exhibited by Curtiss & Waterhouse of New York at the recent Motor Boat Show, the pump is said to be a new application of hydrostatic principles which are very old and simple, and to be reliable and cheap to operate. It can be used on steam, gas or gasoline engines, for lifting water to floors above the engine, for pumping water into tanks, for pumping oils or acids and particularly for circulating water through engine jackets and for bilge purposes.

The diagram shows it connected to a small marine gasoline engine. At the first explosion, part of the exhaust gases enters the

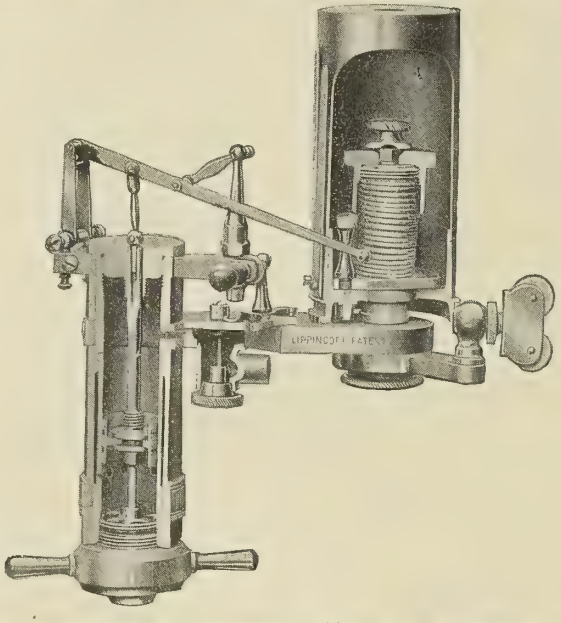


pump through *A* and into *C*. This creates a vacuum which operates to draw water through a check valve and supply pipe, *E*, and fills in and around *A*. After this the successive impacts from the explosions act upon the air in *A*, causing it to drive part of the water out through outlet *D*, which creates a vacuum in chamber *C* and again renews the supply of water through *E*, thus maintaining the water in pump at or about the level shown at *F*.

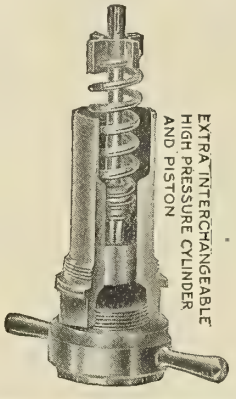
The pump is a single casting, and the simplicity of the pipe attachment and check valve stands out in strong contrast to the usual gearings, sprockets, chains, eccentrics, straps, plungers, packing and oil cups that require so much attention. For multiple-cylinder engines, where the water is discharged into the exhaust pipe, and for slow-running stationary engines that are lifting water to a considerable height, a check valve is used in the discharge pipe in addition to the one in the supply pipe. But for circulating water through the jackets of automobile engines or other engines of that class, no valves whatever are used, and there is absolutely nothing to wear out, nor is there any limit to the speed at which the engine may be run.

Lippincott High-Pressure Indicator.

Improvements in the indicator manufactured by the Lippincott Steam Speciality & Supply Company, of Newark, N. J., have recently been made. In general design the new instrument is similar to the older pattern, having a frictionless piston which consists of a piston head mounted on the piston rod between two ground steel flanges, and so designed that it has



a very small lateral movement. The rod is guided by an accurate bearing at the top and bottom, and the piston is therefore free to adapt itself to a central position in the cylinder, thereby practically eliminating friction. The exhaust steam is carried away through a swivel elbow which may be turned in any direction, a point which will be appreciated by engineers who are compelled to use the instrument in contracted quarters.



The indicator is fitted with a piston of one-half inch area; but it is accompanied by another interchangeable cylinder of one-quarter inch area for high pressure work. The outfit includes a very compact reducing wheel attached directly to the indicator. This wheel has bushings to adapt it for all ranges of stroke, and a very simple "spring winding mechanism" for adapting the spring in the wheel to different speeds.

Decision has been handed down by Justice Buffington of the United States Circuit Court sustaining the validity of the Robert Munroe patents for man hole covers for boilers. The decision is a very broad one and it is understood will have a good deal of effect in the marine field. The claim is made that the Munroe method is the only up-to-date one for making man holes, which is allowed in marine service where high pressures are used.

TECHNICAL PUBLICATIONS.

Valve Gears For Steam Engines. By Cecil H. Peabody, Professor of Naval Architecture and Marine Engineering, Massachusetts Institute of Technology. Size, 5¾ by 9 inches. Pages, 142; folding plates, 34. 1906, New York. John Wiley & Sons. Price, bound in cloth, $2.50.

This is the second edition of a work intended to be used as a text book for students in engineering colleges. The aim of the work is to give the student a firm grasp of the principles involved in the more usual types of valve gears, and some facility in their application, rather than present an exhaustive treatise covering the vast number of valves and gears now in use. The changes made from the earlier edition are mainly in the way of simplification in methods for solving problems; and include a transfer of the analytical work to an appendix, in which are discussed crank and connecting rod, eccentric and eccentric rod, Stephenson link motion, general equative treatment covering the vast number of valves and gears the Walschaert gear. The mathematics involved includes plain trigonometry, but nothing higher.

Graphic methods are used throughout the book, both for demonstration of principles and for designs of gears. In a few cases, where this form of construction would not be satisfactorily complete, reference has to be made to the appendix. Considerable attention is given to the Corliss gear, particularly with reference to drop cut-off gears.

Eminent Engineers: Brief Biographies of Thirty-two of the Inventors and Engineers Who Did Most to Further Mechanical Progress. By Dwight Goddard, A. S. M. E. Size 5½ by 7¾ inches. Pages, 280; illustrations, 35. New York, 1906. The Derry-Collard Company. Price $1.50.

This little book is a series of short biographies of American and European engineers and inventors, the amount of space devoted to each one ranging from four to twelve pages. The sketches include merely the salient features of the various lives, together with a description of the work for which each is best remembered. Each sketch is illustrated by a portrait of the engineer in question, there being in addition three or four other illustrations covering some of the most important of the work. It will suffice to list the names included in the short biographies, there being sixteen American and sixteen European included. The Americans are: Benjamin Franklin, John Fitch, Nathan Read, Oliver Evans, Robert Fulton, John Stevens, Robert L. Stevens, Eli Whitney, Thomas Blanchard, Elias Howe, John Ericsson, Peter Cooper, George H. Corliss, Alexander L. Holley, William R. Jones, and James B. Eads. The British are: Richard Arkwright, Thomas Newcomen, James Watt, Matthew Boulton, William Murdock, William Symington, Richard Trevithick, Henry Maudsley, George Stephenson, I. K. Brunel, James Nasmyth, Charles Babbage, Sir Joseph Whitworth, Sir Henry Bessemer; German, Alfried Krupp, Sir William Siemens.

Injectors: Their Theory, Construction and Working. By W. W. F. Pullen, M. I. M. E. Size 5 by 7. Pages, 208. Figures, 148. 1906, New York: D. Van Nostrand Company, and Manchester: the Technical Publishing Company, Limited. Price $1.50 net.

This is the third edition of the work, the other two having been issued in 1893 and 1900 respectively. The theory of the injector is taken up in considerable detail, and a large number of forms described and illustrated, both by photographic reproduction and by sketches. Curves are given showing the workings of injectors under various conditions of head and of delivery diameters, and instances are cited where injectors are used for a great variety of purposes. Among these might be mentioned the spraying of oil into a furnace using both oil and coal as fuel; the spraying of steam into a furnace in connection with oil for this same purpose; the use of an injector in connection with the sand box for sanding the rail of a railroad. The historical portion of the work has been placed in the rear and all together, in order that the general reader might follow out the stages of development without having to pick out the individual items from among the mass of theoretical considerations in the rest of the book. Regret is expressed in the preface that the difficulty of securing American examples for illustration and description has cut down the number of devices of American origin in the work to a very considerable degree, nearly everything included being British.

Steam Turbines: Their Development, Styles of Build, Construction and Use. By Wilhelm Gentsch. Translated from the German by Arthur Liddell. Size, 7 by 10¼ inches. Pages, 376. Illustrations, 637, including 19 plates. 1906, New York. Longmans, Green & Company. Price $6.00 net.

The rapidly increasing literature on this very live topic has received a noteworthy addition in the present contribution, which goes into the subject with characteristic German thoroughness in the matter of description and illustration, but which avoids completely all reference to the general theoretical aspects of the situation. This being the case, mathematical treatment is entirely omitted, the work being confined to descriptive material in great profusion, and covering large numbers of different types of apparatus.

The portion of most interest to our readers is the last chapter, which covers seventeen pages, and is devoted to steam turbines for use on shipboard. In this chapter descriptions are given of Parsons outfits, together with some information regarding those of the Rateau and the Schultz turbines, with a list of vessels propelled by Parsons turbines, and with plates showing the arrangements of these turbines in passenger steamers, torpedo boats and small cruisers. Quite a little information is given regarding the vessels in question with regard to dimensions, trials, economy, etc.; and a large amount of data is included in the work as a whole, covering tests of turbines under widely varying conditions, and operating for various purposes.

The use of superheated steam receives rather scanty attention in the chapter devoted to it, but is taken up to some extent in other places in discussion of tests in which superheated steam is used. The utilization of the exhaust steam is given some attention. The subjects of bearings and stuffing boxes are given well deserved attention, these items being, of course, very closely related to the efficient operation of the turbine. Governing appliances are given a chapter in which centrifugal and electrical governors are considered. Some attention is paid to reversing gear and descriptions are given of certain attempts to reverse the direction of operation of a turbine designed to revolve in one direction. As is well known, these attempts have up to date been practically failures, it being found necessary in cases where reversing is desired to resort to the addition on the shaft of a separate turbine for that purpose.

United States Civil Service Commission announces the following examinations:

May 2, electrical assistant in signal service at $900 per annum.

May 2, 3 and 4, structural and mechanical engineer draftsman in the engineering department at large at $1,320 per annum.

May 3 and 4, assistant electrical engineer, signal service in department of California, at $1,400 per annum.

May 9, nautical expert in Hydrographic office, Washington, at $1,000, and Cleveland, at $1,200 per annum.

Applicants in each case should apply to Commission in Washington for form 1312.

The examinations will be held at the usual places throughout the United States.

QUERIES AND ANSWERS.

All reasonable questions concerning marine engineering received from and signed by subscribers will be answered by the Editor in this column. All communications must bear the name and address of the writer.

Q. 330.—I wish to ask for an explanation, in your columns, as to the leading methods of constructing patterns and sweeping molds for propellers; also when one method is used and when another. T. McC. G.

A.—The article beginning on page 184 of this number answers fully the above query.

Q. 334.—Would you kindly answer the following at your first opportunity?

Which is considered the better practice for bracing the top of combustion chamber of a Scotch boiler: the girder brace or the crowfoot braces to shell? E. J.

A.—General practice prefers the girder brace to the crowfoot brace and this form of bracing will be found in nearly all examples of recent high grade practice, especially where high pressures are utilized. In a few cases the girders are reinforced by stays running to the boiler shell.

Q. 337.—As a subscriber through the Coast and Geodetic Survey and a possessor of a copy of *Practical Marine Engineering*, I respectfully request information regarding construction of fire tube boilers, pages 87-88, which states as follows:

"So far as internal pressure is concerned the boiler is twice as strong to resist rupture around girth as lengthwise, etc."

I do not quite fully understand the causes, and I am afraid I could not give as intelligent an answer as I would like to at the examination for Inspector of Boilers, which I intend taking shortly.

(2) Also kindly inform me if you have a very late edition of *Practical Marine Engineering;* the one I possess is of the second edition. M. F. F.

A.—The reason a boiler is twice as strong to resist rupture around the girth as it is lengthwise bears entirely upon the relation between the amount of force applied to disrupt the boiler and the amount of material tending to prevent its being disrupted.

The stress that tends to disrupt a boiler around the girth is made up of the total boiler pressure applied to one end of the boiler, and is, therefore, equal to the pressure in pounds per square inch multiplied by the cross sectional area of the boiler. Expressed algebraically, this will be equal to $p \times \frac{\pi d^2}{4}$. The resistance is that supplied by a circular ring of the boiler material of which the thickness is t and the diameter d. The area of material in this ring is obviously $t \times \pi d$. The amount of stress per square inch of material is found by dividing the first quantity by the second, and the result is $\frac{p d}{4 t}$.

When it comes to a question of rupturing the boiler lengthwise, we find that the steam is pressing against the inside surface of the shell equally in all directions, but it may be shown that the force tending to tear out the boiler along longitudinal seams is equal to the pressure multiplied by the length of the boiler times its diameter. In other words, the total amount of force applied by the internal pressure on the inside of the boiler may be represented by the amount which would be applied upon a longitudinal plane passing through the center of the boiler. It will be seen that in this case the force tending to rupture the boiler is equal to $p \times d \times l$. The resistance is offered by material distributed along the two sides of the boiler, and represented by $2 t \times l$. The stress per square inch of material will be, as before, the former quantity divided by the latter, the value being $\frac{p d}{2 t}$.

If we assume a boiler pressure of 150 pounds gauge per square inch, a mean diameter of 10 feet (120 inches), and a boiler shell thickness of 1 inch, it is readily seen that the stress tending to rupture the boiler around the girth is in this case 4,500 pounds per square inch, while that tending to rupture it longitudinally is 9,000 pounds per square inch.

(2) The second edition of Durand's *Practical Marine Engineering* is the one now current.

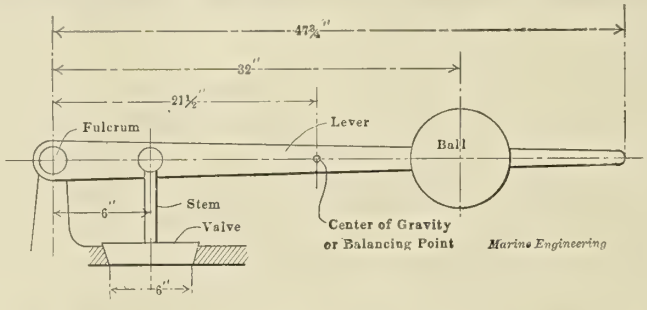
Q. 339.—Will you kindly, in your columns, give me the formula for calculating the period of torsional vibration of a propeller shaft? F. H. B.

A.—The question of the period of torsional vibration of a propeller shaft is a somewhat complicated one, but in general it may be stated that the period may be represented by the following equation: $t = 2 \pi R \sqrt{\frac{ML}{GI}}$ where t is the period in seconds, R is the radius of the crank in inches, M is the mass of the crank reduced to the crank circle, L is the maximum momentary difference between the work of the turning force and the resistance of the propeller, G is the weight of the reciprocating parts of the engine and I is the polar moment of inertia of the entire rotating mass about the center of the shaft.

The formula is from Bauer: *Marine Engines and Boilers.*

Q. 340.—Will you please give in your Queries the United States rules for working out safety valve problems, solved by plain figures. Say we have a safety valve of the following dimensions:—diameter, 6 inches; weight of ball, 160 pounds; length of fulcrum, 6 inches; length of lever, 47¾ inches; balancing point, 21½ inches. The ball is 32 inches from fulcrum; weight of lever, 18 pounds; weight of valve and stem, 15 pounds; steam pressure, 33 pounds. W. M. F.

A.—Our correspondent gives the entire amount of data, leaving no unknown to be determined. Analyzing this data, the diagram shows the general arrangement of the different parts, all of which act about the fulcrum. The pressure of the steam is the only upwardly acting force with which we have to deal. This is represented by a force of 33 pounds per



square inch on a circle of a diameter of 6 inches. The resultant total pressure is readily found to be 933 pounds. This is acting at a distance of 6 inches from the fulcrum and, therefore, constitutes an upward moment of 5,598 inch-pounds, which is to be offset by the combined downward moments of the various parts of the apparatus. The latter moments are three in number, those due to the ball, the lever, and the valve and stem, respectively. In this case the ball, which weighs 160 pounds and is distant 32 inches from the fulcrum, gives a moment of 5,120 inch-pounds; the lever, which weighs 18 pounds and the center of gravity of which is 21½ inches from the fulcrum, gives a moment of 387 inch-pounds. The valve and stem considered collectively weigh 15 pounds, and are at a distance of 6 inches from the fulcrum, thus giving an upward moment of 90 inch-pounds. The aggregate of these three is 5,597 inch-pounds, whence we see that the pressure of 33 pounds per square inch is just about sufficient to cause the valve to lift. In other words, the valve is about to blow off.

Q. 341.—Will you please give United States Rules
(1) To find the pressure at which a safety valve is about to blow off.
(2) To find the distance from the fulcrum to the point at which the weight must act in order to have the valve blow off at a given pressure.
(3) To find the weight which must act on a lever at a given distance from the fulcrum so that the valve will blow off at a given pressure.
(4) To find the downward force on valve due to weight of lever, valve and stem. F. M. W.

A.—The first three of these items depend upon the fundamental equation of the safety valve, which is:

$$Pv = Bb + Ll + (V + S)v,$$

where P is the total pressure of the steam on the valve, B is the weight of the ball, L that of the lever, and V and S

the weights of valve and stem respectively (these two latter are always considered together). The distances from the fulcrum to the valve, the ball and the center of gravity of the lever are respectively v, b and l. If we denote by p the pressure of the steam in pounds per square inch, and by d the diameter of the valve in inches, we find that $P = \frac{\pi d^2 p}{4}$ ($\pi = 3.1416$).

(1) To find the pressure at which the valve is about to blow off, we substitute for P in the fundamental equation its value as just given above, and then solve the resultant equation for p. This gives us a result as follows:

$$p = \frac{4}{vd^2\pi} \times \left\{ Bb + Ll + (V+S)v \right\}.$$

(2) Solving the same equation for b, which is the distance of the weight from the fulcrum, we obtain:

$$b = \frac{vpd^2\pi}{4B} - \frac{Ll}{B} - \frac{(V+S)v}{B}.$$

(3) For the weight of ball to be placed at a given distance from the fulcrum:

$$B = \frac{\pi d^2 pv}{4b} - \frac{Ll}{b} - \frac{(V+S)v}{b}.$$

(4) The downward force on the valve due to the weight of lever, valve and stem is found by dividing the sum of the moments of these items about the fulcrum, by the distance of the valve from the fulcrum. As the valve and stem are already at this same distance, all we have to do is to add to their weight, the quotient obtained by dividing the moment of the lever by the distance of the valve from the fulcrum. Using the same notation as above, and calling F the downward force of lever, valve and stem as applied on the valve, we find that

$$F = \frac{Ll}{v} + V + S.$$

The Bureau of Navigation of the Department of Commerce and Labor reports the construction during March of 87 vessels of a total of 73,519 gross tons. Of this total 15, covering 70,262 tons, are steel vessels propelled by steam. In this list are included 7 of more than 6,000 tons on the Great Lakes, aggregating 47,309 tons, and 1 for the New York and Cuba Mail Steamship Company, of 6,207 tons.

The returns for the quarter ending March 31 show a total of 202 vessels aggregating 106,834 tons, as compared with 159 vessels of 62,744 tons in the corresponding quarter of last year. The increase was entirely on the Great Lakes, there being a net decrease of over 20,000 tons on the Atlantic. Of the present total 19, amounting to 83,837 tons, were on the Great Lakes, and 183 of 22,997 tons, or an average of 126 tons each, elsewhere.

Returns are given for nine months ending March 31, showing the construction of 744 vessels aggregating 242,931 gross tons, of which 76 vessels amounting to 165,741 tons were on the Great Lakes and 668 of 77,190 tons elsewhere. The latter averaged 116 tons, while those on the Great Lakes averaged 2,180 tons. In the nine months, the construction on the Lakes was 142,453 tons greater than last year; that on the Atlantic coast was 52,456 tons less than last year.

Personals.

R. R. Row, formerly superintendent of construction in the U. S. Lighthouse Service has become general superintendent of the marine and mechanical department of the James Reilly Repair & Supply Company, New York, N. Y.

S. H. Pitkin has been appointed first vice-president and general manager of the Wellman-Seaver-Morgan Company of Cleveland, O., to succeed Charles H. Wellman, who was killed last June.

Captain Worth G. Ross of the United States Revenue Cutter Service has been appointed permanent Chief of Division of the Service dating from April 1. Captain Ross succeeds himself, the previous appointment having been for one year.

A new co-partnership of consulting engineers, consisting of John C. Kafer, late superintendent of Quintard Iron Works, Asa M. Mattice, late chief engineer Allis-Chalmers Company and Benjamin H. Warren, late president Allis-Chalmers Company, has been formed under the title Kafer, Mattice & Warren, with offices at 60 Wall street, New York. The scope of the work of the new firm is very considerable. It includes among other things examination and valuation of steamships and yachts, and specifications and plans for marine machinery.

No sooner had this announcement been received than it was learned that on March 30 Mr. Kafer had died at Trenton, N. J., where he was born in 1842. He served in the United States Navy during the latter half of the Civil War, and subsequently until 1885, when he became associated with the Morgan Iron Works, and later with the Quintard Iron Works.

Obituary.

George C. Cook, of the firm of Adam Cook's Sons, manufacturers of lubricants, died suddenly March 21.

New Shipping Lines.

It is reported that a shipping company organized at Cardiff is to establish a line of steamers between Great Britain and the colonies, and it is proposed to construct six ships of 15,000 tons each, driven by steam turbines.

Another report, emanating from Buenos Ayres, states that a company of Argentine capitalists has been organized to establish a line of steamships between Buenos Ayres and the Pacific, the points of call being Puerto Gallegos, Punta Arenas, Valdivia, Coronel, Conception, Valparaiso, Iquique and Callao. The capital of the company is two million dollars in gold, and one large steamer has already been acquired.

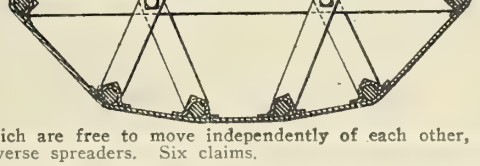
When are the Americans going to start?

SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

808,302. COLLAPSIBLE OR FOLDING BOAT. CHARLES H. PAINE, ENGLEWOOD, N. J.

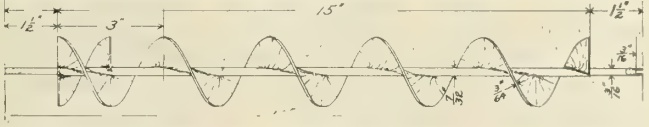
Claim.—1. A boat having a flexible covering, a plurality of resilient longitudinal ribs extending substantially from end to end of the boat, the



ends of which are free to move independently of each other, and one or more transverse spreaders. Six claims.

808,814. PROPELLER-WHEEL. FRANK CHIMZAR, ELY, MINNESOTA.

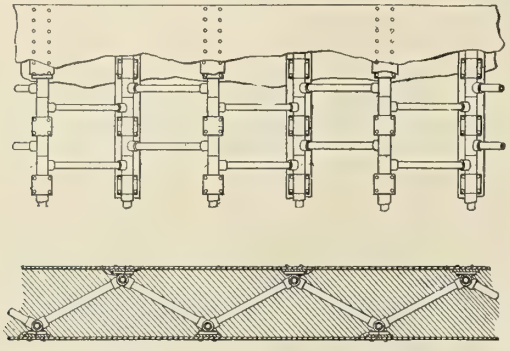
Claim.—The screw-propeller comprising a shaft, the long blade forming a continuous spiral blade of low pitch, having its convolutions extending from



end to end of the shaft, and a short blade opposite to and starting at a point abreast of the front end of the first convolution of the long blade, making one-half a convolution around the shaft and terminating with the first half-convolution of the long blade. One claim.

808,467. METHOD OF CONSTRUCTING VESSELS. EDMOND MOLLOY, PHILADELPHIA, PA.

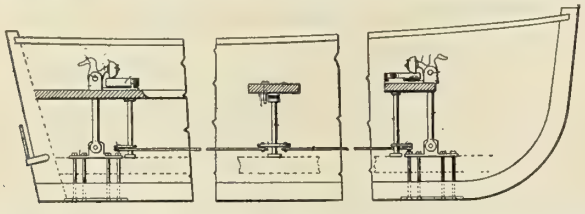
Abstract. The object of the invention is to produce a skeleton framework of novel construction, which is combined with appropriate sections of sheathing and with a suitable backing or filling material in such a way as to produce a simple, strong, and durable structure. The skeleton frame-



work comprises a plurality of runners and sectional stems intermediate of said runners, each stem consisting, preferably, of couplings and adapted for adjustment so as to exert tension on the runners, and thereby produce a rigid skeleton structure. Said skeleton structure and the sheathing are adapted for attachment one to the other, and the spaces between the sheathing and the structure are occupied by the filling or backing material, so as to secure a solid, rigid, and fireproof structure. Seven claims.

808,575. MEANS FOR RELEASING BOATS FROM THEIR FALLS AT BOTH ENDS SIMULTANEOUSLY. G. S. A. RANKING, CALCUTTA, INDIA.

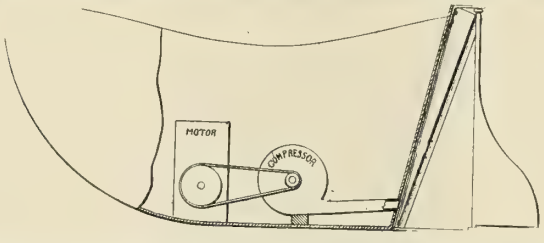
Claim.—4. Means for disengaging a boat from its falls consisting of pivoted hooks, arms on the backs of said hooks and integral therewith, rollers mounted on said arms, cams engaging said rollers, cranks connected



to said cams, a double crank-arm pivoted in its center, connecting-rods between said cranks and opposite sides of said crank-arm, a handle for rotating said crank-arm, and means for locking said handle. Four claims.

808,634. VESSEL-PROPELLING DEVICE. PEET CARLSON, MANOR, TEXAS.

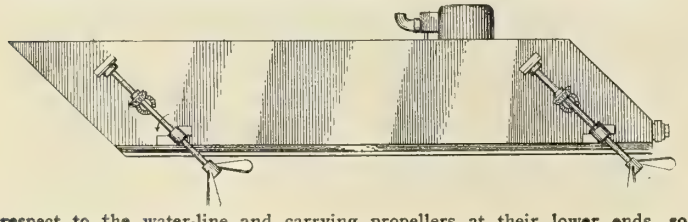
Claim.—1. A vessel having a transversely concaved stern, the side walls of the vessel being extended rearward to form flanges at the opposite sides of said concaved stern, said flanges being arranged on convergent lines



that taper from the upper portion of the stern to a point of convergence adjacent to or below the keel, a discharge-port formed in the stern at a point adjacent to the keel, and means for forcing a stream of compressed air through said port. Two claims.

809,064. MARINE VESSEL. JOHN E. JOHNSON, ISHPEMING, MICHIGAN.

Abstract.—The object of this invention is to provide means for propelling marine vessels which will at the same time decrease the resistance offered by the hull to this propulsion. In attaining this end are provided peculiarly-arranged propeller-shafts mounted diagonally on the vessel with



respect to the water-line and carrying propellers at their lower ends, so that upon the rotation of the shafts the propellers exert a combined lifting and propelling force on the hull, causing it to displace less water, and consequently enabling it to be driven with less resistance. Two claims.

810,032. PROPELLER. ALEXANDER T. BROWN, SYRACUSE, NEW YORK.

Claim.—1. The combination with the shaft of a reversible propeller, of the divided hub, the reversible blades pivoted between the front and rear sections of the hub and provided with the cranks, the sliding head movable lengthwise of the shaft and having flanges contiguous to the cranks, pin-and-slot connections between the cranks and the flanges, said flanges being situated in planes tangential to the shaft, and each crank rotating in a plane parallel with and closely adjacent to a flange, said plane cutting the proximate flange transversely near its base. Fourteen claims.

810,042. MOORING DEVICE. WILLIAM D. DUNCAN, BOSTON, MASSACHUSETTS.

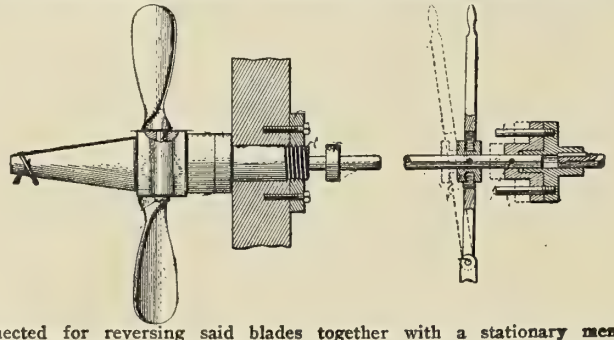
Claim.—A mooring device provided with a drum and adapted to have one end of a hawser connected therewith, combined with a cable connected with said drum, and means to move said cable, said cable when moved causing the mooring device to disengage itself from the hawser. Five claims.

810,185. COVER FOR SHIPS' HATCHWAYS. HENRY BURRELL, GLASGOW, SCOTLAND.

Abstract.—The cover of the hatchway or opening is made in the form of a door or doors of iron, steel, or other suitable material, which may be hinged at the ends or sides of the hatchway or may be portable, as may be most convenient. When fitted to large hatchways, across each door or cover a strong beam or beams is or are provided of such strength as will withstand the weight of any water which may fall upon the cover. The cover is further strengthened by stiffening-bars of angle or other suitable section fitted at right angles to and connected with said beam or girder and extending to the coamings of the hatchway. By this means the cross-beams and fore and aft supports usually fitted under the hatch-covers may be dispensed with, and the opening of the cover or door at once leaves the hatchway entirely clear for working cargo, the cover itself being hinged back on deck or lifted clear of the hatchway. The beam or girder or stiffeners being fitted on the top of the cover when covering the hatchway, the whole internal space in the hatchway itself is left free for the stowage of cargo and a plane surface is provided for working upon when the hatchway is open, which plane surface may also serve as a chute for coal and similar cargoes. Six claims.

811,287. REVERSIBLE PROPELLER. FRANK GRAY, MUSKEGON, MICH.

Claim.—1. A reversible propeller-wheel comprising adjustably-mounted blades, the blades being mounted on an axially-adjustable and rotary head, and a longitudinally-adjustable propeller-shaft supported for rotation and



connected for reversing said blades together with a stationary member having an annular groove engaged by portions rigid with the said blades. Twelve claims.

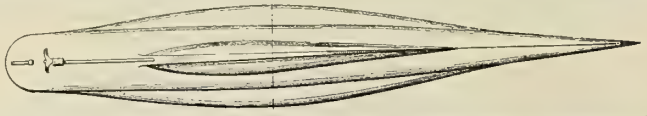
811,815. LIFE-SAVING BOAT. AUGUST BAUMGART, LIND, WASH.

Abstract.—The object of the invention is to provide a life-boat so constructed that the force of the waves shall be compensated in striking the life-boat, so that the force of the waves and the water will be wholly expended upon an outer movable cover to protect the life-boat proper; and a further object is to provide a means whereby the approximately barrel-shaped housing or outer cover may be permitted to revolve freely with the wash of the water or the movement of the waves; and the still further object is to prevent the longitudinal movement of the approximately barrel-shaped housing or cover. Seven claims.

811,887. HIGH SPEED MOTOR BOAT. THOMAS WHELESS, NEW YORK.

Claim.—6. A high-speed motor-boat having fine lines below the water-

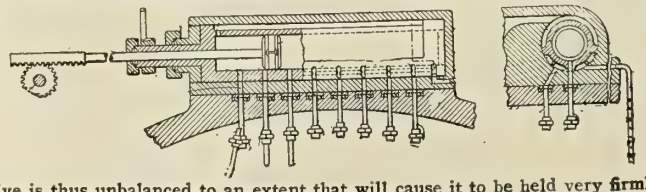
line and having buoyancy-chambers provided at each side above the water-line and tapering upward and outward and also being inclined downward



from the bow aft, and being provided with a hollow keel weighted at its base and opening upward into the boat. Ten claims.

811,987. MARINE TURBINE. JAMES WILKINSON, BIRMINGHAM, ALA., ASSIGNOR TO WILKINSON TURBINE COMPANY, A CORPORATION OF ALABAMA.

Abstract.—An object of this invention is to provide an improved controller-valve that will be held to its multiported seat in a manner to prevent any leakage of pressure around the same. To this end the valve is exposed above to a high pressure and has one or more channels or recesses on its lower side to which the atmosphere or low pressure is admitted so that the



valve is thus unbalanced to an extent that will cause it to be held very firmly to its seat. According to this construction high pressure is used to open the turbine valves, which are closed by springs or other constant pressure acting against them or their motors, when either is exposed to low pressure by the controller valve. Twenty-six claims.